A star (*) indicates that the Abstract deals with Apparatus and Instruments.

OCTOBER, 1939.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

3840. Application of Thermodynamical Notions to Normal State of Nucleus. S. Watanabe. *Zeits. f. Physik*, 113. 7–8. *pp.* 482–513, 1939.—The usual one-body approximation in the theory of nuclear structure is improved by allowing for the fact that the energy of any nuclear particle is subject to wide fluctuations, owing to its exchanging energy with the other particles. These fluctuations are treated in analogy with thermal fluctuations. R. P.

3841. Recent Experimental Results in Nuclear Isomerism. B. Pontecorvo. *Nature*, 144. *pp.* 212–213, *July* 29, 1939.—A review. A brief summary is given of the experimental verifications of the theory that one of a pair of isomeric nuclei is in an excited metastable state and that the angular momentum of this state differs by several units from the ground state. Most of this work has been on radioactive isomers, the ground and excited states exhibiting different half-life periods. Theory indicates that the γ-radiation emitted in the transition from the metastable to the ground state should have an internal conversion coefficient of almost unity, and experimentally this radiation has been examined by measurements on the electrons thus produced. Experiments are described in which β-stable nuclei are excited by a continuous spectrum of X-rays and metastable states are created with half-life periods of several hours. In this case the line spectrum of emitted electrons is produced by the internally converted γ-rays emitted when the excited nucleus falls to the ground state. W. E. D.

3842. Protium-Deuterium Ratio and Atomic Weight of Hydrogen. J. A. Swartout and M. Dole. *Am. Chem. Soc., J.* 61. *pp.* 2025–2029, *Aug.*, 1939.—Water containing normal Lake Michigan O and pure H has been prepared by an exchange reaction in the gas phase: $H_2 + HOD = HD + HOH$. The density of this water has been found to be $15{\cdot}5 \pm 0{\cdot}1$ p.p.m. lighter than normal Lake Michigan water. From this the ratio of H atoms to D atoms was calculated to be 6970. Water containing normal Atlantic Ocean O and pure H was prepared by the same method. The difference in density between this and normal Atlantic Ocean water was found to be $15{\cdot}7 \pm 0{\cdot}2$ p.p.m., corresponding to a H/D ratio of 6900. D-free H_2 was burned with atmospheric O_2 and the density of the water produced was compared with that of water containing normal Lake Michigan O and pure H. The atmospheric O_2 water was found to be 6·6 p.p.m. heavier, which corresponds to a greater atomic weight of O in air of $0{\cdot}000119 \pm 0{\cdot}000002$ atomic weight units. The chemical atomic weight of hydrogen as calculated from our new H/D ratio is 1·0080 instead of the value of 1·0081 recently adopted by the International Committee on Atomic Weights. AUTHORS.

3843. "Effective Electron Density" and Chemical Behaviour. Heou-Feo Tseou. *Am. Chem. Soc., J.* 61. *pp.* 2161–2163, *Aug.*, 1939.—It is pointed out that many properties of an element depend on the density of its valence electrons in a covalent compound. This characteristic is called the effective electron density, and is determined from the number of valence electrons and the covalent atomic radii of the metals. In doubly and triply bonded atoms the radii are smaller and the effective electron densities are higher than in singly bonded atoms. High effective electron densities are associated with high electronegativity. Stable polyatomic chains are associated with elements that have intermediate effective electron densities. Covalent bonds between atoms of high and low effective electron densities degenerate to ionic linkages. AUTHOR.

3844. Forces in Molecules. R. P. Feynman. *Phys. Rev.* 56. *pp.* 340–343, *Aug.* 15, 1939.—Formulæ have been developed to calculate the forces in a molecular system directly, rather than indirectly through the agency of energy. This permits an independent calculation of the slope of the curves of energy *vs.* position of the nuclei, and may thus increase the accuracy, or decrease the labour involved in the calculation of these curves. The force on a nucleus in an atomic system is shown to be just the classical electrostatic force that would be exerted on this nucleus by other nuclei and by the electrons' charge distribution. Qualitative implications of this are discussed. AUTHOR.

3845. Mechanism of Orientation in *i*-Butyl and *i*-Amyl Bromide Glasses. W. O. Baker and C. P. Smyth. *J. Chem. Phys.* 7. *pp.* 574–577, *Aug.*, 1939.—The relaxation times of two typical, unassociated polar molecules have been calculated from experimental dispersion data. Both Stokes' law and absolute reaction rate theories have been applied to show that the inner friction constant in the usual Debye relaxation formula must be considered in terms of a mechanism involving higher activation energies than those obtaining in ordinary viscous flow. Hence, the macroscopic viscosity will generally be inadequate as an inner friction constant for relaxation. Slight alterations in the structure of these molecules are found apparently to change their relative orientations and hence energies of interaction. Rotational motion in viscous flow of lesser degree but similar kind to that of relaxation is indicated by the parallelism between the respective energies in *i*-butyl and *i*-amyl bromides. Possible generalisations have been extended to relaxation and flow phenomena in liquid crystals, where effectively the co-existence of phases derived from a single component over a temperature range makes the structure considerations simpler than in the usual case of solutions. AUTHORS.

3846. Structure of Fluorene. W. C. Lothrop. *Am. Chem. Soc., J.* 61. *pp.* 2115–2119, *Aug.*, 1939.—Methods which have been useful for the location of double bonds in other aromatic hydrocarbons have been applied to fluorene, with the result that the latter may be said to be benzenoid rather than naphthoid. Fluorene has been found to possess no considerable fixation of bonds as might be expected if the Mills-Nixon effect were operating and it is suggested that the special reactivity of positions 2 and 7 may be ascribed to the superior directive properties of the phenyl group. AUTHOR.

3847. Molecular Size of Starch. M. L. Wolfrom, D. R. Myers and E. N. Lassettre. *Am. Chem. Soc., J.* 61. *pp.* 2172–2175, *Aug.*, 1939.—Potato starch has been hydrolysed with a concentrated solution of HCl at 0° in the presence of an excess of ethyl mercaptan. The resulting

mercaptalated mixtures of hydrolysed products were isolated as their acetates at various time intervals, during the first 26 hours of the hydrolysis. Sulphur analytical data indicated that the average degree of polymerisation of the mercaptalated products varied from 17 glucose units after 0·5 hr. to 2 glucose units after 26 hr. The course of the hydrolytic reaction (without mercaptalation) at 0° was followed by optical rotation measurements. A graphic analysis of the data yields a value of $2 \cdot 66 \times 10^{-2}$ for the specific rate constant (hours $^{-1}$) of the rate of change of the degree of polymerisation in concentrated HCl at 0°. By graphic analysis the value 20 ± 4 glucose units is obtained for the initial average degree of polymerisation of the potato starch. [See also Abstract 2674 (1939).]

AUTHORS.

See also Abstracts 3923, 3924, 3979, 4152.

COLLOIDS.

3848. Interaction Between two Hydrophobic Colloidal Particles. Part I. General Properties. Part II. Numerical Computations of Energy Function. S. Levine and G. P. Dube. *Faraday Soc., Trans.* 35. *pp.* 1125–1156, *Sept.*, 1939.—In Part I applying a general formula, which has been developed to calculate the interaction energy of two spherical, hydrophobic colloidal particles, first, second and third approximations are obtained. The results depend upon the use of the approximate Debye-Hückel equation in the theory of electrolytes. Both metallic and insulating particles have been considered. The first approximation corresponds to undistorted penetration of the double layers, the second to induced effective dipoles, the third to effective quadrupoles and so on. A very simple method of obtaining a rough estimate of the first approximation has been given. This yields all the essential features of the more exact results. A comparison is made of the authors' theory with those of Langmuir and Derjaguin, whose results are shown to be unsatisfactory. The relation of the authors' work to the basic assumptions in the Debye-Hückel theory is discussed, and it is seen that the negative term in the mutual energy between two particles should also exist for two ions of the same sign. This has been omitted by Debye and Hückel and is negligible for dilute electrolyte concentrations but important at strong concentrations. In Part II numerical calculations are carried out on the interaction energy of two colloidal particles, treating the cases described in Part I. It is seen that for small particle radii or low electrolyte concentrations the first approximation is fairly accurate. For larger particles or more concentrated solutions of electrolyte the correction from the higher approximations may be quite considerable depending upon the amount of redistribution of charge on the surfaces of the interacting particles. [See Abstract 3084 (1939).]

AUTHORS.

3849. Structure and Properties of Highly Purified Reduction Gold Sols. W. Pauli, J. Szper and S. Szper. *Faraday Soc., Trans.* 35. *pp.* 1178–1183, *Sept.*, 1939.—A new method has been developed for preparing larger amounts of reduction gold sols by means of ethyl alcohol. These gold sols were purified and highly concentrated by a newly perfected electro-decantation process. Analysis of the sols and of the liquid obtained by freezing coagulation shows that the sols have, as charging ionogenic groups, auro-chloro complexes which can partially hydrolyse to mixed chloro-hydroxy complexes. The results are in full harmony with those obtained with other types of gold sols.

AUTHORS.

3850. Composition of Colloidal Pt Micelle. S. W. Pennycuick. *Am. Chem. Soc., J.* 61. *pp.* 2234–2237, *Aug.*, 1939.—The colloidal Pt micelle, after isolation by freezing from Bredig preparations, has been analysed by microchemical methods. The composition of the micelle of an average preparation can be given by the formula $[3{\cdot}9\ Pt,\ 1{\cdot}16\ PtO_2,\ 1{\cdot}0\ H_2Pt(OH)_6]_n$. There is evidence that the whole of the water in the micelle is present in the form of the highest hydrate, $PtO_2{\cdot}4H_2O$, which is hexahydroxyplatinic acid. The total amount of this acid (in the micelle and in solution) is 27·2 % of the gross weight of the particles. On continued boiling the greater part of this remains in the micelle, where some appears to be in the interior. The precipitate formed on ageing is less rich in stabilising material than is the ordinary micelle. The light-gray wastage in the Bredig vessel is practically pure Pt. AUTHOR.

3851. Coagulation of Sols by Electrolytes. Wo. Ostwald. *Kolloid. Zeits.* 88 *pp.* 1–17, *July*, 1939.—The author gives a general account of his theory that the coagulating forces are to be identified with the interionic attraction forces between ions of the dispersion medium, as measured by the activity coefficient of the solution. L. A. W.

3852. Sedimentation Potentials in Centrifuging Colloidal Solutions. K. Hoffmann. *Kolloid. Zeits.* 88. *pp.* 17–21, *July*, 1939.—An account is given of preliminary experiments in which it is shown that a measurable p.d. is set up when a colloidal solution is centrifuged in ordinary centrifuges. The potential in question is transferred by means of Hg contacts from the moving cell to a valve voltmeter. A negative As_2S_3 sol gives a potential of the opposite sign from that for a positive TiO_2 sol. Potentials up to 6 mV are observed and their relation to viscosity, concentration and specific resistance is found to be in accordance with theoretical considerations. L. A. W.

3853. Influence of Ionic Strength and pH on Electrophoretic Mobility. B. D. Davis and E. J. Cohn. *Am. Chem. Soc., J.* 61. *pp.* 2092–2098, *Aug.*, 1939.—The electrophoretic mobility of carboxyhemoglobin has been studied at 25° in phosphate and citrate buffers, varying in pH from 5·65 to 7·2, and in ionic strength from 0·02 to 0·20. Over this range the influence of ionic strength upon mobility is of the same order as that of pH. Corrections for the influence of electrostatic forces both in diminishing mobility and in changing the isoelectric point are considered. Whereas the computations attempted on the basis of these results do not preclude ion association, they yield constants for the effect of the buffers at constant pH, and at constant pH intervals from the isoelectric condition. Carboxyhemoglobin has a net charge due to the dissociation of twelve or more imidazole groups at the most acid reactions investigated. Not only mobility but diminution in mobility due to electrostatic forces is a function of the net charge, and therefore increases with distance from the isoelectric condition. AUTHORS.

3854. Rhythmic Precipitates. T. Isemura. *Chem. Soc. Japan, Bull.* 14. *pp.* 179–237, *June*, 1939. *Supplement. In English.*—The conditions of the formation of various rhythmic precipitates are studied. The effects are tested of the change of species and concentrations of gel, inner electrolyte and outer electrolyte, the temperature, the light intensity and the H-ion concentrations of medium and outer electrolyte solution. The regularity of spacing between bands is also studied. The distance between bands is expressed empirically by the quadratic equation concerning the ordinal number of it. The same equation is deduced from a theoreti-

al standpoint, the physical meaning of the equation being considered. Classification of the rhythmic precipitates by the cause of formation and by the structure is proposed. Secondary bands are investigated and discussed. New examples of rhythmic precipitate are described, i.e. barium chromate, cobalt phosphate, lead carbonate, lead phosphate, lead iodate, silver arsenate, silver carbonate, silver iodate and silver capronate in gelatin gel, and bismuth chromate, bismuthyl chloride, bismuthyl nitrate, cobalt phosphate, cobalt sulphide, copper carbonate, copper iodate, cerium iodate, calcium phosphate, calcium oxalate, strontium oxalate, ferric ferrocyanide, lead carbonate, lead iodate, lead phosphate, nickel dimethylglyoxime, silver arsenate, silver ferrocyanide, silver phosphate, silver iodate, uranyl phosphate and uranyl arsenate in silicic acid gel. The conditions for the formation of these rhythmic precipitates are thoroughly investigated. AUTHOR.

3855. Changes in Structure of Coal Tar Due to Progressive Evaporation of the Oily Medium. A. Léauté. *Comptes Rendus*, 209. *pp.* 308–310, *July* 31, 1939.—Tar films have been examined under a microscope and subjected to air circulation and raised to a temperature of 60° C *in situ*. By thus observing exactly the same portion of the specimen it was found that clouds gradually form round certain large particles which act as centres to which the smallest particles slowly migrate in spite of the high viscosity attained by the tar. This procedure provides a means of studying the ageing of tars. J. B. W.

See also Abstract 4013.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

3856. Photography of Interatomic Distance Vectors and of Crystal Patterns. M. J. Buerger. *Nat. Acad. Sci., Proc.* 25. *pp.* 383–388, *July*, 1939.—In a recent note, [*Nature*, 143. *p.* 678, *April* 22, 1939], W. L. Bragg has described an optical method of effecting the two-dimensional Fourier summation $\int x, y = \Sigma\Sigma_{hol} \cos\{(2\pi hx/a) + (2\pi lz/c) + \alpha_{hol}\}$ which gives the electron density, $\int$, of all points, x, z, of a crystal structure projected on (010). The method provides a practical method of rapid synthesis in the cases of crystals all of whose diffraction spectra have the same phase, *i.e.*, $\alpha_{hol} = 0$. In the present note suggestions are made for (a) extension of the method to cases where α is either 0 or π, (b) extension to Patterson and Harker summations for determining interatomic distance sectors, and (c) reductions of many of the steps to purely photographic processes. J. S. G. T.

3857. Normal Modes of Vibration of a Body-Centred Cubic Lattice. P. C. Fine. *Phys. Rev.* 56. *pp.* 355–359, *Aug.* 15, 1939.—An atomic model is set up for the purpose of finding the normal modes of vibration of a body-centred cubic lattice. A method is presented for selecting suitable atomic force constants from the macroscopic elastic properties of W, which satisfy the isotropy condition but not the Cauchy relation. Actual solutions of the secular equation are then carried out under the assumption that each atom is affected by only its 14 nearest neighbours. Numerical computations yield a frequency distribution characterised by two steep maxima. This is used in evaluating the specific heat and the intensity of reflection of X-rays as functions of temperature, and the results are compared with the Debye theory. AUTHOR.

3858. Critical Behaviour of Solid Solutions in Order-Disorder Transformation. H. A. Bethe and J. G. Kirkwood. *J. Chem. Phys.* 7. *pp.* 578–582, *Aug.*, 1939.—A discussion of critical phenomena in the order-disorder transformation from the standpoint of the theories of Bethe and Kirkwood is presented. A comparison of the two theories is undertaken, and the best values of the transition temperatures and heat capacity anomalies, ΔC_v, for the simple cubic and body-centred cubic lattices are tabulated. The influence of anomalies in the coefficients of expansion and compressibility on the anomaly in the heat capacity C_p is investigated. AUTHORS.

3859. Dendritic Structures. Part 1. Influence of Crystal Orientation. L. Northcott and D. E. Thomas. *Inst. of Metals, J.* 65. [12 *pp.*], 1939. *Advance Copy.*—The lattice orientations of crystals in special ingots of some Cu-rich alloys have been correlated with their dendritic structure. Columnar crystals were oriented so that a (100) plane was parallel to the direction of growth; equi-axial crystals were of random orientation. The lines composing the dendritic structure were found to be outcrops of {100} planes on the face of the crystal being examined; the lines became broader and more diffuse as the (100) plane approached the plane of the crystal face. A simple method of determining the crystal orientation from the dendritic structure is suggested. AUTHORS.

3860. Structure of Divalent Cobaltinitrites. A. Ferrari and L. Coghi. *Gazz. Chim. Ital.* 69. 1. *pp.* 3–10, *Jan.*, 1939.—The authors prepared the cobaltinitrites of Pb and Ba, but it was found impossible to obtain those of Sr and Cd by double decomposition between Na cobaltinitrite, $Sr(NO_3)_2$ and Cd cobaltinitrite (Ogburn's method), nor could solid solutions of the divalent cobaltinitrites be obtained. Structural examination showed a very strict analogy between the lattices of the $Pb^{\cdot\cdot}$ and Ba salts and the monovalent salts, some of the lattice positions belonging to the monovalent kations remaining unoccupied. From this it is deduced that the H_2O molecules are present as water of crystallisation and not in chemical combination. For $Pb_3[Co(NO_2)_6]_2$ and $Ba_3[Co(NO_2)_6]_2$, lattice constants and densities of the anhydrous salts are respectively 10·42 Å and 3·785; 10·57 Å and 3·040. D. R. H.

3861. Structure of Beryllium Carbonate. G. Venturello. *Gazz. Chim. Ital.* 69. 2. *pp.* 73–86, *Feb.*, 1939.—Attempts to prepare basic Be carbonates are found to yield products of indefinite characteristics. Measurements by the powder method with the use of Hadding's formula give a hexagonal unit cell with $a = 5{\cdot}12$ and $c = 15{\cdot}77$ Å; in all photographs of basic carbonates two lines corresponding to those of $Be(OH_2)$ appear. D. R. H.

3862. Structure of Pressure Modification of Saltpeter. T. F. W. Barth. *Zeits. f. phys. Chem.* 43. *Abt. B.* 6. *pp.* 448–450, 1939.—The compound KNO_3 (saltpeter) is rhombic at ordinary but trigonal at higher temperatures, and rapid cooling of the latter form produces a metastable variety designated by Kracek as KNO_3 III. This modification belongs to the ditrigonal pyramidal class with space-group C^5_{3v}. The element cell contains one molecule KNO_3 with $a_o = 4{\cdot}365$ Å, and $\alpha = 76°\ 56'$ (at 120° C); K in *ooo*, N in *ppp* with $p = 0{\cdot}56$, O in *uuv* $\circlearrowright$ with $u = 0{\cdot}45$ and $v = 0{\cdot}78 + 0{\cdot}02$. The coordination number for K is 9, with distance K—O = 2·95 Å. The NO_3 group is structurally flat, and is not in the centre of the cell but situated 6 % higher. H. H. Ho.

3863. Structure of Hexamethylbenzene and Length of Methyl Group Bond to Aromatic Carbon Atoms. L. O. Brockway and J. M. Robertson. *Chem. Soc., J. pp.* 1324–1332, *Aug.*, 1939.—The crystal structure of hexamethylbenzene has been re-investigated with the aid of the double Fourier series method of interpreting the intensity data. The projection along the *c* axis leads to an electron-density contour diagram in which two of the methyl C atoms are entirely resolved. The distances to the centre of the molecule are 2·92 Å, which, with measurements on the ring, lead to a ring size of 1·39 Å and methyl group bond lengths of 1·53 Å. The lower values (1·47—1·49 Å) previously reported for durene and dibenzyl may be less reliable because of the less favourable orientations of the molecules in the projections. The present result is in agreement with electron-diffraction data and shows that a methyl group bond attached to a fully substituted benzene ring has the same length as in saturated aliphatic hydrocarbons. The shorter single-bond lengths reported in stilbene, tolan, diphenyl, etc., are the result of conjugation of the side chain with the benzene nucleus. The minimum intermolecular approach distances are 3·70 and 3·87 Å between C atoms and 2·0 — 2·2 Å between H atoms. Comparison with the closest intermolecular approach of H atoms in solid methane (1·97 Å) shows that the hexamethylbenzene molecules are packed as closely as the H–H repulsions will allow. With the molecules lying very nearly in the (001) plane, the structure is triclinic instead of monoclinic because the former arrangement allows a closer packing amounting to a 9 % greater density. AUTHORS.

3864. Structure of Liquid Potassium. N. S. Gingrich and C. N. Wall. *Phys. Rev.* 56. *pp.* 336–339, *Aug.* 15, 1939.—The method of Wall for calculating the free volume per atom in a liquid has been applied to liquid K, using the atomic distribution curves for K at 70° C, and at 395° C. given by Thomas and Gingrich. From the free volumes at these temperatures, the entropies of the liquid at its melting point and at its boiling point are obtained. These values, together with the entropy of solid K at its melting point and the entropy of K vapour at its boiling point, supply the entropies of fusion and of vaporisation. Hence the latent heat of fusion is calculated as 2·06 *kj*/mol, and the latent heat of vaporisation is calculated as 87·5 *kj*/mol. These values are to be compared with the observed values 2·38 *kj*/mol and 84·0 *kj*/mol, respectively. AUTHORS.

3865. Retardation of Transitions between Ordinary and Crystalline Liquids. C. Weygand and R. Gabler. *Zeits. f. phys. Chem.* 44. *Abt. B.* 1. *pp.* 69–74, 1939.—Positive experimental data are now recorded with respect to the problem of the supercooling of ordinary and crystalline liquids, in which the transformation temperatures between different liquid-crystal form types have been avoided, and the transitions thereby retarded. Illustrative diagrams are included for the systems isopropoxy-isopentoxy-1-benzalamino-naphthalene-4-azobenzene and n-nonoxybenzal-1-aminonaphthalene-4-azobenzene with n-nonoxybenzal-1-aminobenzene-4-azobenzene. For the explanation of the phenomena it is assumed that different orders of aggregation depend on phase boundaries formed with defined velocities, but that the first appearance of such a boundary, *i.e.*, of a condensation or crystallisation nucleus, depends on the occurrence of chance atomic or molecular nuclei which may be considerably delayed. H. H. Ho.

3866. Crystal Growth Problems. H. E. Buckley. *Manchester Lit. and Phil. Soc., Mem.* 83. *pp.* 31–62, 1938–1939.—Previous work is

briefly discussed, and the author's numerous results summarised. The comparative habit-changing efficiency of different " impurities " (mostly dyes), added in small amounts to the crystallising solution) is measured. This varies with the nature of the crystallising material, and the molecular structure of the " impurity ". Thus presence therein of $NaSO_3$– groups is the surest method of producing habit-change, NaCOO– groups have a less effect, OH– (in alkaline solution) still less, while much depends on the position in the molecule of a dye of these groups. Other somewhat vague generalisations are given, but a fundamental explanation remains to be discovered. Finally pleochroism produced by the presence of the dye is discussed. [See Abstract 4085(1935).] C. A. S.

3867. Crystallisation of Vitreous Metaphosphates of Na and Ca. R. Pâris and A. Boullé. *Comptes Rendus*, 209. *pp.* 223–225, *July* 24, 1939.—The softening and crystallising points of the nitreous metaphosphates of Na and Ca were examined by differential thermal analysis, softening curves (determination of rate of sinking of a steel point at different temperatures), and by plotting velocity of crystallisation against temperature. The results show that in both cases the commencement of softening coincides with the lower limits of crystallisation, which are at about 280° and 520° respectively, which are also the transformation points of the glasses. Velocity of crystal development is a maximum at 440° and 760° respectively. C. A. S.

3868. Crystallo-Chemical Analysis. M. W. Porter and R. C. Spiller. *Nature*, 144. *pp.* 298–299, *Aug.* 12, 1939.—Rules have been laid down to decide which is the " main classification angle " of a crystalline substance, and how to determine it. These angles are listed in order of magnitude (the " Barker list "), and so enable the substance to be identified, of course, in many cases with further aid from easily observed physical constants and chemical properties of the substance. An actual test with 16 substances was successful in 15. C. A. S.

See also Abstracts 3845, 4077, 4094, 4095, 4096, 4137, 4138, and 2061B. X-Ray Study of Ag-Cd Alloys. E. A. Owen, J. Rogers and J. C. Guthrie.

DENSITY.

See Abstracts 3842, 3926.

DIFFUSION AND OSMOSIS.

3869. Theory of Diffusion Potential, Stationary Diffusion and Henderson Distribution. L. G. Sillén. *Phys. Zeits.* 40. *pp.* 466–473, *July* 15, 1939.—The general equations have been derived for a state of stationary diffusion between two different solutions of electrolytes, whereby the Planck differential equations have been obtained in modernised form. The conditions have also been investigated for a stationary diffusion with a Henderson distribution (every part of the intermediate layer being an additive mixture of the two bounding solutions). The problem is also investigated both for ideal and for dilute solutions with monovalent ions only, since the activity coefficients and the thermodynamic functions which determine alterations in ionic mobility, are the same functions of the total concentration for all the ions. The paper is entirely mathematical. H. H. Ho.

3870. Permeability of Metal Membranes to Diatomic Gases. R. M. Barrer. *Phil. Mag.* 28. *pp.* 353–358, *Sept.*, 1939.—It is shown that

the calculations of Wang [see Abstract 46 (1937)] which indicate that the permeation rate through a metal plate can be infinite at infinite pressure, are due to incomplete rate equations for some of the phase boundary processes assumed by him. Using the completed rate equations, expressions for the permeation rate for the six-phase boundary processes assumed by Wang are then given, and it is shown that the permeation rate is always finite whatever the pressure. The Fick law for the stationary state of flow is then used to show that, whatever phase boundary processes are assumed, the permeation rate can never under any conditions approach infinity. An explanation of the persistence of linear permeation-rate — $\sqrt{p}$ isotherms up to 112 atm. is given from the findings of the previous paper [see Abstract 3520 (1939)], where it was shown that very great discontinuities in concentration may occur at the boundaries of the plate, and concentrations just inside the ingoing face of the metal may exist in non-equilibrium systems, which are very small compared with the saturation value of this concentration. Under these conditions, which may persist to high pressures, a $\sqrt{p}$ law is obeyed. AUTHOR.

See also Abstracts 4083, 4103.

ELASTICITY AND PLASTICITY.

3871. Equation of Partial Derivatives in the Theory of Movement of a Plastic Body. C. W. Oseen. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 26*B*. 15. [4 *pp.*], 1939. *In French.*—The author shows that the mathematical equations for movement of a plastic body in a plane are completely integrable although they cannot be integrated by the usual methods applied to Monge-Ampère equations. J. B. W.

3872. Rate of Plastic Deformation in Lead under Compression. W. J. Lyons. *J. of Applied Physics*, 10. *pp.* 651–653, *Sept.*, 1939.—It is shown that the velocities of plastic deformation, deduced from previous experimental data on lead cylinders, are in satisfactory accord with the relation $v = a \exp(bP)$, where a and b are constants, and P is the prevailing pressure. Integration of this equation leads to the following expression for deformation as a time-function: $\epsilon = 1 + (1/bP_0) \ln (abP_0t + C)$, where P_0 is initial pressure and C is a constant of integration. Means for evaluating C are given. This equation, requiring adjustments in only a, is found to represent very well the observed relations between deformation and compression-time for four different initial pressures. It is concluded that plastic deformation in lead is governed principally by the exponential law for velocity. [See Abstract 4318 (1938).] AUTHOR.

3873. Velocity of Propagation of Disturbances in Inextensible Membranes. M. Pastori. *Accad. Lincei, Atti*, 29. *pp.* 411–417, *April* 15, 1939.—The formula $v^2 = T/k$ for the velocity of propagation in terms of the tension T and the density k holds generally even if the membrane is brought to an arbitrary shape by external static forces, provided v is defined as the normal velocity of the line of separation between the part already affected by a disturbance and the rest of the membrane. If the tension is not isotropic, T is the diagonal component referring to the normal to the line of separation. R. P.

3874. Effects of Humidity and Composition on Strength and Young's Modulus of Enamels. D. G. Moore and W. N. Harrison. *Bureau of Standards, J. of Research*, 23. *pp.* 229–343, *Sept.*, 1939.—Both Young's modulus and the modulus of rupture of eight types of enamel

frit were determined under constant conditions of temperature and humidity, by transverse loading of annealed fibres about 0·75 mm. in dia. One enamel fired on metal specimens was also tested under varying conditions of humidity for resistance to chipping in torsion. Fibres of two of the frits were tested in air under different humidities at constant temperature, immersed in different liquids at constant temperatures, and immersed in water-free kerosene at different temperatures. The most noteworthy effect observed was that of humidity upon the modulus of rupture of the frit fibres and also upon the resistance of enamelled-iron specimens to chipping in torsion. AUTHORS.

See also Abstracts 3857, 3929, 4109.

GRAVITATION.

3875. Modified Newtonian Law. J. Chazy. *Comptes Rendus*, 209. *pp.* 133–136, *July* 17, 1939.—The author criticises the modified form of the gravitational law $F = -fmm'(1 + \epsilon\, dr/dt)/r^2$, where ϵ is a small constant of dimensions the inverse of a linear velocity V (identified with that of light). With this form of the law, planetary orbits present an analogy with damped vibrations, tending towards circular trajectories as equilibrium states. It is shown, however, that Mercury and the Earth respectively would suffer mean longitude inequalities of 40″ and 0″·1 per revolution, which are quite inadmissible, and are, moreover, proportional to the square of the time. The results of the law are compared with those in which gravitation is given a finite velocity of propagation. These first-order perturbations are allowable only if V has a value many times greater than the velocity of light. Laws previously proposed to explain the advance of the perihelion of Mercury involve only second-order terms, which produce effects of the right order of magnitude. A. HU.

See also Abstract 3957.

HYDRODYNAMICS AND AERODYNAMICS.

3876. Equations of Permanent Relative Flow of a Perfect Fluid, and the Hypothesis of Currents. M. Roy. *Comptes Rendus*, 209. *pp.* 187–190, *July* 24, 1939.—The permanent, adiabatic flow of a perfect fluid relative to axes in uniform rotation and, if desired, having, in addition, a uniform velocity of translation parallel to the axis of rotation, is discussed mathematically. A transformation of the classical equations of the motion in Eulerian variables is effected in order to develop the significance of the intrinsic energy, entropy, the limiting velocity and absolute turbulence of the fluid, and more especially to develop the conditions of constancy of these characteristics. The hypothesis of currents is concerned with the orthogonality of the relative turbulence and the relative velocity of flow. J. S. G. T.

3877. Flow of Compressible Fluid Past Circular Cylinder. K. Tamada and Y. Saitō. *Phys. Math. Soc., Japan, Proc.* 21. *pp.* 403–409, *July*, 1939. *In English.*—The flow of a compressible fluid past a circular cylinder is discussed by employing Poggi's method and the correct second approximation has been found. The result is in agreement with that of Imai [see Abstract 4325 (1938)] by a different method, but not with those of Poggi and of Kaplan. AUTHORS.

3878. Velocity Distribution in a Liquid-into-Liquid Jet. Part II. The Plane Jet. E. N. da C. Andrade. *Phys. Soc., Proc.* 51. *pp.* 784–792; *Disc.*, 792–793, *Sept.*, 1939.—The distribution of velocity in a jet

issuing from a long slit has been measured and compared with two-dimensional theory. The plane jet is difficult to realise experimentally, but the experiments indicate that the distribution of velocity in the neighbourhood of the orifice approaches that given by theory if the ideal jet be considered to issue from a true line source situated behind the actual slit, which is of finite breadth, at a distance for which an expression has been found. The Reynolds number for turbulence has been found. [For Part I see Abstract 3391 (1937).] AUTHOR.

***3879. Saturation of Gases by Laboratory Wet Test Meters. F. A. Smith and J. H. Eiseman.** *Bureau of Standards, J. of Research*, 23. *pp.* 346–353, *Sept.*, 1939.—A laboratory wet test meter registering 1/10 c. ft. per revolution has been studied by the National Bureau of Standards, at the request of a committee of the American Society for Testing Materials, to determine : (*a*) how nearly the gas passing through the meter becomes saturated with water from the meter, (*b*) the error in the indicated volume resulting from a lack of complete saturation at different rates of flow, and (*c*) the error in the indicated volume resulting from failure to level the meter. Saturation of dry air was found to be over 98 % complete at all practicable rates of flow. The directly observed error in the indicated volume was found to be less than 0·2%. Errors resulting from failure to level the meter were found to be less than 0·1%, provided the quantity of water in the meter was the same as at calibration. AUTHORS.

3880. Influence of Density of Gaseous Surroundings on Propagation of Liquid Jet. R. Kling. *Comptes Rendus*, 209. *pp.* 153–156, *July* 17, 1939.—In certain cases [see Abstract 2272 (1938)] Mach waves are formed at the point of a liquid jet. To study the conditions on injection into motors trials have been made by throwing the liquid (gas-oil) into a bomb furnished with windows and filled with a gas under pressure. The jet was photographed by the method of striations, using two electric sparks, an interval being made to avoid the superposition of the two images on the screen. The time interval was controlled by a turning drum. Thus the mean velocity of the front of the jet can be determined. It was found that the pressure of the gas played an essential part in the pulverisation of the jet. At atmospheric pressure the jet has the aspect of a long spindle with a Mach wave at the point for high pressures of injection. When the gaseous pressure increases the velocity of propagation of the extremity of the jet decreases causing the disappearance of the Mach wave. Lateral waves appear increasing in number with the pressure of the gas. Some of these indicate supersonic velocities and curve towards the orifice with high pressures showing a slowing down of the projectiles which they produce. J. J. S.

See also Abstract 4088.

KINETIC THEORY OF MATTER.

3881. Plane and Linear Brownian Motion. P. Lévy. *Comptes Rendus*, 209. *pp.* 140–142, *July* 17, 1939.—This note rounds off the writer's mathematical scheme for representing and specifying Brownian motion [see Abstract 961 (1939)]. **Errata,** *ibid. p.* 387, *Aug.* 16, 1939. W. S. S.

See also Abstract 4084.

MASS.

***3882. Magnetic Operation of Chemical Balances. J. P. Blewett.** *Rev. Sci. Instruments*, 10. *pp.* 231–233, *Aug.*, 1939.—Two types of balance are described for measuring small weights by application of a magnetic force in place of the usual system of calibrated weights. One method is applied to an analytic balance, the other to a vacuum balance. AUTHOR.

***3883. Differential Torsion Balance. K. H. Stehberger.** *Zeits. f. techn. Physik*, 20.7. *pp.* 217–220, 1939.—A light balance beam is carried at the centre of a relatively stiff wire, and is adjusted so that alteration in the torsion of the wire is very nearly balanced by the corresponding tilting of the beam. This arrangement enables the difference between relatively large loads suspended at the ends of the beam to be determined to high accuracy. P. H. B.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

3884. Mixed Problem for the Wave Equation. R. Einaudi. *Accad. Sci. Torino, Atti*, 74. *Disp.* 4*a*. *pp.* 470–480, *April–June*, 1939.—The author is concerned with the solution of the partial differential equation of wave motion in a given domain and time interval when the initial values of the wave variable and of its first time derivative at each point of the domain are prescribed as well as the values of the wave variable on the boundary of the domain throughout the given time interval. It is shown that subject to certain continuity restrictions there exists a unique solution of the wave equation satisfying the stated boundary conditions. [See following Abstract.] W. S. S.

3885. Solution of the Mixed Problem for the Wave Equation in a Spherical Domain. R. Einaudi. *Accad. Sci. Torino, Atti*, 74. *Disp.* 4*a*. *pp.* 481–491, *April–June*, 1939.—The solution of the mixed problem for the wave equation [see preceding Abstract] is worked out for the case of a spherical domain and is reduced to the integration of a number of easily integrable ordinary differential equations. W. S. S.

3886. Harmonic Analysis by the Method of Central Differences. D. C. Espley. *Phil. Mag.* 28. *pp.* 338–352, *Sept.*, 1939.—A method for the treatment of non-linear characteristics is described. The analysis is not limited to any number of values of a tabulated function. To facilitate numerical calculation a table of constants is included, so that the direct evaluation of harmonics up to the fifth can be obtained from characteristics determined by a maximum of eleven points. Particular reference is made to distortion in thermionic valves, although the method is not limited to such cases. AUTHOR.

3887. Tests of Significance of Differences between Regression Coefficients. F. Yates. *Roy. Soc. Edinburgh, Proc.* 59. 2. *pp.* 184–194, 1938–1939.—Tests of significance of the differences of regression coefficients derived from two sets of correlated dependent and independent variates are described. The necessary computations are reduced to a systematic and easily calculable form, and are illustrated by a numerical example. AUTHOR.

***3888. Small Differential Analyser. J. E. Lennard-Jones, M. V. Wilkes and J. B. Bratt.** *Cambridge Phil. Soc., Proc.* 35. *pp.* 485–493, *July*, 1939.—Describes the design and constructional details of a machine for integrating differential equations mechanically. The machine consists of a series of mechanical integrating units, together with input and output tables, which can be interconnected by means of a flexible system of

shafting with removable gears. The solution is given in the form of a curve drawn mechanically on the output table. Meccano parts are largely used in the construction. Using the analyser to solve the wave equation for the H atom an accuracy of 1 part in 500 was obtained. [See following Abstract.] H. B.

***3889. Automatic Curve Follower for Use with Differential Analyser. P. M. S. Blackett and F. C. Williams.** *Cambridge Phil. Soc., Proc.* 35. *pp.* 494–505, *July*, 1939.—When the differential analyser [see preceding Abstract] is being used it is sometimes necessary to supply information to the machine in the form of a functional relation between variables occurring in the equation. This may be done by hand control of a pointer over a graph situated on the input table, but the automatic curve follower here described enables the operation to be performed more conveniently and accurately. The action of the follower is controlled by a photocell detecting device and the average departures from a curve placed on the input table do not exceed 0·025 in. [See following Abstract.] H. B.

***3890. Reversible Head for Automatic Curve Following Device. F. C. Williams.** *Cambridge Phil. Soc., Proc.* 35. *pp.* 506–511, *July*, 1939. —The automatic curve follower [see preceding Abstract] operates satisfactorily if the x-coordinate either continuously increases or continuously decreases, but it cannot handle input functions in which the x value pulsates. The reversible head described here enables this difficulty to be overcome by means of a modification of the optical detecting device. The accuracy of following of the input curve was found to be within 0·025 in. H. B.

See also Abstracts 3871, 3936, 4026, 4081.

MECHANICS, CLASSICAL.

3891. Free Fall. F. Odone. *N. Cimento*, 16. *pp.* 155–158, *March*, 1939.—Galileo had expected the increase of velocity to be proportional to the change in height, but had then concluded that this law would lead to a contradiction. Mach's statement that the law would be logically consistent is shown to be erroneous. R. P.

3892. Principle of Shortest Path for Impulsive Motion. G. Arrighi. *Accad. Lincei, Atti.* 29. *pp.* 259–264, *March* 18, 1939.—In the configuration space a line element is introduced in which the coordinates of each particle appear multiplied by the square root of its mass. If the system is subject to any finite forces and constraints, and at a certain instant additional constraints are introduced, the subsequent motion is such as to make the change in direction as small as possible without violating the constraints. If all possible directions of motion after the new constraints have been introduced are at right angles to the initial direction, the velocity after the impact is zero. Otherwise it is determined by a relation involving the change of direction. R. P.

3893. Inhomogeneous Sphere Rolling on Plane. G. Peretti. *Accad. Lincei. Atti.* 29. *pp.* 418–421, *April* 15, 1939.—The problem of a sphere rolling on a horizontal plane without slipping and without rolling friction can be reduced to quadratures even if the distribution of mass in the sphere is not uniform, provided it has axial symmetry. R. P.

See also Abstracts 3931, 3932.

MECHANICS, QUANTUM.

3894. Self-Consistent Field, Including Exchange and Superposition of Configurations, with some Results for Oxygen. D. R. Hartree, W. Hartree and B. Swirles. *Roy. Soc., Phil. Trans.* 238*A*. *pp.* 229–247, *July* 24, 1939.—In the simplest approximation to the structure of a many-electron atom, each term is regarded as arising from a single configuration of one-electron wave functions. When, to this approximation, two or more configurations give terms of the same parity, *L*, and *S*, not greatly different in energy, an appreciably better approximation may be obtained by taking, as the wave function for each term, a linear combination of the wave functions for the various configurations. The term "superposition of configurations" is used to denote the use of such linear combinations. The effect of this superposition of configurations can be taken into account in the calculation of energy values only, or in the determination of the one-electron wave functions also. The latter requires an extension of Fock's equations, and in the present paper this extension is worked out for the superposition of the $(np)^{q+2}$ configuration on the normal $(ns)^2(np)^q$ configuration of atoms with an incomplete 8-shell. The solution of these equations involves a set of calculations, each of which is similar to a complete solution of Fock's equations, for a set of trial values of a parameter expressing the relative amplitudes of the wave functions of the two configurations. For O^+, the normal configuration $(2s)^2(2p)^3$ gives ^4S, ^2D, and ^2P terms, of which only the highest (^2P) is subject to the superposition of the $(2p)^5$ configuration. A full solution of the extended equations has been worked out for this case. The effect of superposition of configurations on the radial wave functions is found to be small, less than 1 in 200 of their greatest values, and the consequent effect on the total energy of the $(2s)$ $(2p)$ shell very small, about 1 in 4000. This small improvement of the energy value did not seem to justify the solution of the extended equation for other states of ionisation, and for these solutions the ordinary Fock equations only have been evaluated, though superposition of configurations has been taken into account in calculating energy values. AUTHORS.

3895. Particles with Any Spin. L. de Broglie. *Comptes Rendus*, 209. *pp.* 265–268, *July* 31, 1939.—In developing the theory of the photon, the author has been led to a general method of obtaining the wave mechanics of a particle of any spin, by considering it as a combination of several particles of spin 1/2. The case of a particle of spin 2, made up of two particles of spin 1, or four particles of spin 1/2 is discussed. G. O. B.

3896. Reciprocity and the Number 137. Part I. M. Born. *Roy. Soc. Edinburgh, Proc.* 59. 2. *pp.* 219–223, 1938–1939.—Following an idea of Landé, a generalised wave mechanics is developed which is suited to describe the existence of particles with finite dimensions. The quantum constant divided by the product of an absolute energy and an absolute time appears as the parameter in a linear homogeneous integral equation of the Fredholm type, and the numerical determination of the number "137" is reduced to the calculation of an eigenvalue. AUTHOR.

3897. Electron Energies. T. Gustafson. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26*A*. 15. [28 *pp.*], 1939.—*In German.*—In determining the specific energies of electrons interacting with light quanta, a method using the determinants of the exact solution of the wave equation, is employed. In the simplest case the energies of an electron interacting

with photons emitted by a single oscillator are considered. Secondly the author deals with the case of the energies of an electron in reciprocal action with the photons from two oscillators, and finally the problem of n oscillators is discussed. It is concluded that the difficulties of the application of quantum electrodynamics to electrons are not so much mathematical as physical. G. O. B.

See also Abstracts 3840, 3844, 3884, 3885, 3899, 3903, 3904, 4098, 4103.

PRESSURE.

***3898. Circulation and Purification of Noble Gases at Pressures above 0·02 mm. of Hg. B. Vogel.** *Zeits. f. techn. Physik.* 20. 7. *pp.* 220–222, 1939.—Describes a mechanically operated pump on the Töpler principle for circulating gases at pressures between 5 and 100 Torr. in a closed system. Data relating to the purification by this means of the inert gases, particularly as regards hydrocarbons and H_2, are given in detail. P. H. B.

See also Abstract 4090.

RELATIVITY AND ETHER.

3899. Electrodynamic Interaction of a Particle with the Electromagnetic Field, and the Geometry of the Universe. P. Caldirola. *N. Cimento,* 16. *pp.* 136–146, *March,* 1939.—The electromagnetic field equations which have been formerly developed [see Abstract 2357 (1939)] are discussed. The behaviour of material particles placed in an electromagnetic field is studied, and it is shown that electrons and heavier particles (protons and neutrons) produce a variable curvature of the universe while the curvature remains constant in the case of a purely electromagnetic (photonic) field. L. K.

3900. Question in General Relativity. L. I. Schiff. *Nat. Acad. Sci., Proc.* 25. *pp.* 391–395, *July,* 1939.—The following apparent paradox is discussed and resolved: Consider two concentric spheres with equal and opposite total charges uniformly distributed over their surfaces. When the spheres are at rest the electric and magnetic fields outside the spheres vanish. When the spheres are in uniform rotation about an axis through their centre the electric field outside vanishes while the magnetic field does not, since the magnetic moment of each of the spheres is proportional to the square of its radius. Suppose the spheres are stationary: an observer travelling in a circular orbit round the spheres should find no field, for since all of the components of the electromagnetic field tensor vanish in one coordinate system they must vanish in all coordinate systems. On the other hand the spheres are rotating with respect to this observer and so he should experience a magnetic field. The analysis shows that the electric and magnetic fields vanish outside the spheres in both cases of relative motion. J. S. G. T.

See also Abstracts 3938, 4071.

SOLUTION.

3901. Theory of Solutions. Part II. K. Fredenhagen and W. Schulze. *Zeits. f. phys. Chem.* 43. *Abt.B.* 6. *pp.* 439–447, 1939.—This extension of previous work [see Abstract 2729 (1938)] discusses the meaning of partial molar quantities in the theory of solutions viz. (1) These quantities were defined by G. N. Lewis for the partial molar volumes and

energies as the differential changes of the total volume and energy of a solution with respect to the molecular number of its components taken separately. (2) The conclusion that the dissolved substances in a solution possess volumes and energies which correspond to the partial molar quantities defined by Lewis is only permissible when the molecular numbers of the mixed substances are preserved and when each molecule of the same substance possesses the same volume and energy. (3) These two assumptions, however, are only fulfilled, if the volume and energy of the solution are linear functions of the volumes and energies of its pure substances. In this case the partial molar quantities become identical with the corresponding properties of the pure substances. H. H. Ho.

See also Abstracts 4035, 4053, 4106.

SURFACE PROPERTIES.

3902. Sorption of Gases on Reduced Nickel. Part II. M. Takebayashi. *Chem. Soc. Japan, Bull.* 14. *pp.* 290–294, *July*, 1939.—Results of experiments on the sorption of HBr at 0°, of HCl at 0° and 20°, and of HBr through CCl_4, and CCl_4 containing a little catechol, on finely divided reduced Ni are given. More HBr was adsorbed in the presence of the catechol. [For Part I see Abstract 1944 (1939).] A. J. M.

3903. Surface States Associated with a Periodic Potential. W. Shockley. *Phys. Rev.* 56. *pp.* 317–323, *Aug.* 15, 1939.—The wave functions and energy levels associated with a finite one-dimensional periodic potential field are investigated. In a plot of the energy spectrum *versus* interatomic distance the surface levels appear only at lattice constants so small that the boundary curves for the allowed energy bands have crossed. The levels appear in the "forbidden" region between allowed bands in pairs one coming from each of the adjoining bands. In three dimensions these surface levels give rise to surface bands. The surface bands probably exist and are half-filled for diamond. They exist for all metals and are entirely unoccupied only for the monovalent metals. Author.

3904. Use of Surface States to Explain Activated Adsorption. W. G. Pollard. *Phys. Rev.* 56. *pp.* 324–336, *Aug.* 15, 1939.—A theory is advanced connecting activated adsorption with electron surface states in solids. The theory is constructed for H_2 but the suggested mechanism would work equally well for other molecules. It is supposed that H atoms interact with surface electron states of the solid when the atom gets close enough to make the latter stable. The stability condition for surface states and its relation to the position of the visiting H atom is investigated in some detail. If the energy of the surface state is low enough, the atom will on reaching the critical distance for stability transfer its electron to the surface state with considerable reduction in total energy. At close distances, exchange sets in. The energy of the various interactions is calculated approximately on the basis of a simplified model of the surface potential field and the surface state wave function. By using a reasonable form for the repulsion between the H nucleus and the positive cores in the metal, total energy curves whose minima lie at depths up to 2·5 volts are obtained. An H_2 molecule with sufficient energy may get close enough to the surface to come into the range of interaction of the H atoms with surface states. When this happens the molecule can split into atoms and be bound as such to the surface. The present theory of this interaction seems

to be capable of properly accounting for the observed heats of activated adsorption of H_2. AUTHOR.

3905. Adsorption of cis- and trans-Azobenzene. H. Freundlich and W. Heller. *Am. Chem. Soc., J.* 61. *pp.* 2228–2230, *Aug.*, 1939.—The adsorptions of pure *cis*- and *trans*-azobenzene by Al_2O_3 and by charcoal in solutions of petroleum ether and of methyl alcohol were measured and compared. The *cis* isomer is adsorbed more strongly by Al_2O_3, particularly in petroleum ether, less in methyl alcohol; the *trans* isomer is adsorbed more strongly by charcoal, particularly in methyl alcohol, less in petroleum ether. This is in agreement with other experimental results. according to which the more hydrophilic solute, here the *cis* isomer, is adsorbed more strongly by a hydrophilic adsorbent, here Al_2O_3, in a more hydrophobic medium, here petroleum ether, than by a more hydrophobic adsorbent, here charcoal, in a more hydrophilic medium, here methyl alcohol. That *cis*-azobenzene is more hydrophilic than *trans*-azobenzene is also shown by the *cis* isomer being more strongly soluble in water and methyl alcohol and less soluble in petroleum ether than the *trans* isomer. AUTHORS.

3906. Adsorption of Hydrous Metallic Oxides by Kieselguhr. E. C. C. Baly, W. P. Pepper and C. E. Vernon. *Faraday Soc., Trans.* 35. *pp.* 1165–1175, *Sept.*, 1939.—Pure kieselguhr adsorbs the anhydrous oxides of Al, Th, Ni and Co. The adsorbate in each case is activated as the result of the formation of adsorption complexes. In the cases of the oxides of Al and Th the adsorption is restricted to a single unimolecular layer. In the cases of the oxides of Ni and Co there are adsorbed three unimolecular layers together forming a single layer of crystal unit cells. When a mixture of NiO and ThO_2 in the molecular ratio of 1 ThO_2 : 24 NiO is adsorbed, one out of every seven groups of 4 Ni and 4 O atoms in each of the three layers of the crystal lattice is replaced by a molecule of ThO_2. This is also true when CoO us substituted for NiO. AUTHORS.

3907. Surface Tension Activity of Antipyrin and Its Alkyl Derivatives. A. Giacalone and D. Di Maggio. *Gazz. Chim. Ital.* 69. 2. *pp.* 122–129, *Feb.*, 1939.—The surface tension activity of the series antipyrin, 4-isopropyl antipyrin, 4-isobutyl antipyrin, 4-isoamyl antipyrin is determined, and found to increase with the length of the carbon chain, and Traube's rule [*Chem. Zentr.* 1913. *II*, 1072] is confirmed. It is conjectured that the pharmacological action is determined by this length. For $N/10$ solutions at 25·9° C. γ is found to be 63·63 for antipyrin, against 60·06 for aspirin and 71·6 dynes/cm. for H_2O, the increased surface tension activity of the aspirin being in accordance with its stronger physiological action. D. R. H.

3908. Surface Tension Activity of Geometrical Isomers. A. Giacalone. *Gazz. Chim. Ital.* 69. 3. *pp.* 198–206, *March*, 1939.—The surface tension activity (lowering of surface tension per unit of solute) is reported for a number of isomeric organic acids. For the pair malic/fumaric, the second is more tension-active than the first. For the pair citraconic/mesaconic, on the other hand, the first (*cis*-form) is more effective than the second; for these the ratio of concentrations for iso-capillarity is about 1·7. By comparison of the surface tension activity of maleic acid and its homologues, Traube's rule is found to be valid for the pair maleic/mesaconic. The bearing of geometrical form of the molecule on the superficial arrangements is discussed. D. R. H.

***3909. Surface Tensions of Molten Glasses. C. W. Parmelee, K. C. Lyon and C. G. Harman.** *Univ. of Illinois Eng. Exp. Sta., Bull. No.* 311. [47 *pp.*], *June* 6, 1939.—In Part I the surface tensions of seven molten sodium borosilicate mixtures were determined at temperatures between 1050° C. and 1330° C. by the maximum bubble pressure method. The capillary tube was of Pt(60%) + Rh(40%) and its lower end was held at the level of the liquid surface. As a result of preliminary investigation it was arranged that bubble formation should take place at the rate of 1 bubble in from 2 to 10 min. The temperatures of the samples were determined by means of a standardised thermocouple placed on the capillary tube close to its end, and the densities were found by weighing a Pt ball in separate melts. In view of possible criticism on account of the high viscosity of glass, some satisfactory measurements of the surface tension of glycerin, which has the same viscosity, were undertaken. The determined surface tensions of the glasses varied from 230 to 290 dynes/cm. Increase of SiO_2 increases the surface tension and density while both Ba_2O_3 and Na_2O decreases them. The glasses were all heated to 1250° C. before the measurements since an irreversible change at 1250° C. was noted. In Part II the surface tensions of an important part of the soda-lime-silica system were investigated from 1030° C. to 1450° C. by the same apparatus and method, but with greater control in the process of bubble formation. Densities were not determined. It was found that the increase of CaO rapidly increases the surface tension of these melts, which have a minimum, 278 dynes/cm., at 72% SiO_2. Increase in CaO decreases the effect of Na_2O and SiO_2, while the surface tension is nearly proportional to the CaO content and curves of constant viscosity tend to lie parallel to lines of constant SiO_2. The addition of CaO reduces the temperature coefficient.
P. H. B.

3910. Interfacial Tension of Hg. N. V. R. Iyengar and B. S. Rao. *Indian Acad. Sci., Proc.* 10*A. pp.* 31–36, *July*, 1939.—A new method has been described for controlling the rate of formation of drops in the drop-weight method for the determination of surface tension and interfacial tension with Hg as one of the phases. Interfacial tension of Hg has been measured in systems containing (*a*) H_2S and SO_2 in CCl_4, solution, (*b*) S in CCl_4 solution, (*c*) potassium mercuric iodide in aqueous solution, and (*d*) potassium mercuric cyanide in aqueous solution. Certain interesting features of the results obtained are discussed. AUTHORS.

3911. Electron Scanning for Revealing Structure of Surfaces and Thin Films. M. Knoll and R. Theile. *Zeits. f. Physik*, 113. 3–4. *pp.* 260–280, 1939.—The normal electron-optical method of examining an object is to irradiate the whole surface simultaneously. A method is now proposed for using a very narrow electron beam which is caused to scan the surface of the object. The object is mounted on a metal plate in a high-vacuum tube and the plate is connected, through an amplifier, to the deflecting plates of an oscillograph which is coupled to the electron scanning arrangement in the object tube so that the scanning and recording electron beams are synchronised. An image is obtained on the screen of the oscillograph due to secondary emission of electrons from the object; the structure of the object is made visible owing to differences in the secondary emission of different parts of the object. The method is not limited to conducting objects but may be applied to bad and non-conductors by suitable modification of the circuits. The " geometrical " and " con-

trast " resolving power of the electron scanning system are briefly discussed and illustrated. H. J. H. S.

3912. Nature of Foam. Part VI. T. Sasaki. *Chem. Soc. Japan, Bull.* 14. *pp.* 250–258, *June*, 1939.—[For Part V see Abstract 2372 (1939).]

3913. Physical States of Protein Films. D. Dervichian. *Comptes Rendus*, 209. *pp.* 156–158, *July* 17, 1939.—An interpretation of the results recently obtained on A and B films of proteins is given [see Abstract 3167 (1939)]. The viscosity of a B film will be greater than that of an A film because of its greater thickness, and because the actual B film contains active groups which increase its cohesion. In A films the number of polar groups in contact with H_2O is a maximum. For B films this number increases with time, and at each successive compression. A. J. M.

3914. Expanded Monolayers of Myristic and Pentadecylic Acids. G. C. Nutting and W. D. Harkins. *Am. Chem. Soc., J.* 61. *pp.* 2040–2046, *Aug.*, 1939.—The effect of temperature upon the pressure (f) at constant molecular area (a) of monolayers of myristic and pentadecylic acid has been determined. The value of the slope $(\partial f/\partial T)_a$ has been found to be of the order of 0·8 to 1·2 for intermediate, and of 0·15 to 0·2 for expanded films. Pressure–area isotherms for myristic acid have been determined at temperatures from 6·7 to 25°. The compression of intermediate films is found to involve a process which takes time for its completion, and in which at constant temperature the pressure increases with time at constant area, or the area with time at constant pressure. At constant temperature an intermediate film seems to undergo a gradual transition into a condensed liquid film by increase of pressure and the resulting decrease of molecular area. The condensed liquid film exhibits a linear pressure-area relation, and in the case of pentadecylic acid at 25° undergoes a sharp transition to a "plastic" solid film at 21·3 dynes per cm. and 20·52 sq. Å. For any long straight chain molecules the molecular area for the transition liquid → solid is very much more independent of the material of the film than the pressure. Authors.

3915. Optical Surface Thickness of Pure Water. J. W. McBain, R. C. Bacon and H. D. Bruce. *J. Chem. Phys.* 7. *pp.* 818–823, *Sept.*, 1939.—An apparatus and method is described, based on the optical theory of Drude, capable of measuring surface film thickness of less than a monomolecular order of magnitude. The retardation in phase sustained by plane polarised light at a transparent reflecting surface is compensated and measured by tension on a thin glass microscope cover slip. The method is applied to pure water and the results indicate that the least possible thickness of the water surface is 2–3 Å. The ellipticity from water at the polarising angle is estimated by two observers to be 33×10^{-5} and 42×10^{-5}. Authors.

3916. Study of Films at Liquid/Liquid Interface. Part III. A. E. Alexander, T. Teorell and C. G. Åborg. *Faraday Soc., Trans.* 35. *pp.* 1200–1205, *Sept.*, 1939.—In view of the possible biological significance the effect of various kations on monolayers of kephalin at the benzene/water and air/water interfaces has been examined. At the air/water interface there was little marked effect, although Ca ions caused a slight condensation of the film and an increase of some 30–40 mV in the surface potential. At the benzene/water interface Ca ions showed a specific effect, which was not given by either Na, K or Mg ions although a similar effect was obtained on strongly acid and alkaline substrates (*e.g.* $N/10$

HCL and *N*.NaOH). This effect has been shown to be a stabilisation of the kephalin in the interface, preventing its dissolution into the benzene phase. The cause of the stabilising action of Ca ions and some possible biological inferences are discussed. [For Parts I and II see Abstract 2754 (1939).] AUTHORS.

***3917. Portable Motor-Driven Apparatus for Depositing Built-Up Molecular Films. S. J. Gregg and E. E. Widdowson.** *Rev. Sci. Instruments*, 10. *pp.* 236–237, *Aug.*, 1939.—A description is given of a simple motor-driven apparatus for the deposition of built-up molecular films on plane solid surfaces. Special features of the apparatus are its portability and simplicity of construction, and it is suitable both for lecture demonstrations and for research. AUTHORS.

3918. Oiliness of Liquids. Parts VII and VIII. T. Isemura. *Chem. Soc. Japan, Bull.* 14. *pp.* 270–273, *June, and pp.* 297–302, *July*, 1939.—In Part VII the static friction coefficients are measured when esters, ketones and glycerin are placed on a glass surface as lubricants. The high friction coefficients of these liquids are discussed. The coefficients of water and methyl alcohol are revised. In Part VIII the friction surfaces consisted of a silver plate and a silver piece of spherical surface. The static friction coefficients of water, hydrocarbons, aliphatic alcohols, aliphatic acids and esters were measured. The static friction coefficients of these compounds excepting the acids are all comparable with the results obtained for the glass surfaces. The friction coefficients of acids diminish rapidly with the number of C atoms in the chain of the molecule for the silver surfaces, while they are nearly constant irrespective to the number of C atoms for glass surfaces. [For Part VI see Abstract 1872 (1938).] AUTHOR.

See also Abstracts 4133, 4134 and 2059B. Molecular Physics of Lubrication. K. L. Wolf.

TIME.

3919. Periodic Fluctuations of Clocks at Greenwich and Göttingen. H. Gockel. *Zeits. f. Physik*, 113. 3–4. *pp.* 188–191, 1939.—The deviations from astronomical time of a Shortt clock at Greenwich and of two Schuler pendulum clocks at Göttingen are examined over a 4-month period. There is a noteworthy parallelism in the $\Delta t/t_{ast}$ curves for the three clocks, especially in respect of the times at which sudden changes in the sense of the clock deviations occur; it is considered the parallelism in clock readings is not accidental but due to some common external influence the nature of which is as yet unknown. J. E. K.

3920. Comparison between Methods of Time Determination. S. Hayne. *Bull. géodésique, No.* 60. *pp.* 356–389, *Oct.–Nov.–Dec.*, 1938.—*In German.*—The author compares some common means of determining time in the field for geodetic purposes. Three azimuth methods and one zenith method are reviewed: these involve observations of (1) transits in the vertical circle of Polaris, (2) transits in the meridian, (3) transits of pairs of stars in the meridian, and (4) equal altitudes of pairs of stars. The discussion of mean errors of the clock corrections so determined places these methods in the order 3, 2, 4, 1; of observational convenience in the order 2–3–4, 1; and of computational convenience, 2–3, 1–4. The complete discussion takes all points of view into consideration, and places them in the order 3, 2, 4, 1. The paper concludes with a discussion of programme selection for time and azimuth determinations by observations of transits and of equal altitudes. [See also Abstract 3937 (1939).] A. HU.

***3921. Indicator Device for Short Time Measurements Based on the Process of Luminous Ray Detection. F. Winckel.** *Zeits. f. techn. Physik*, 20. 8. *pp.* 244–246, 1939.—In this paper an instrument is described which is claimed to be an improvement on the rotating glow lamp for rapid time measurements. The service rendered by the latter instrument is discussed with reference to its accuracy, and alternatively a method is proposed for using a fixed glow lamp in conjunction with a rotating spirally perforated disc. It is shown finally that for very rapid time measurements the Braun tube affords the greatest detection efficiency. H. H. Ho.

***3922. Spark Recording of Data. C. Tuttle.** *Kodak Research Lab., Comm. No.* 723. *Rev. Sci. Instruments*, 10. *pp.* 234–235, *Aug.*, 1939. —An electrode for use with an instrument which records data by the firing of a spark through graph paper and a relay circuit which acts to limit the discharge to a single spark are described. AUTHOR.

VISCOSITY AND FRICTION.

3923. Dependence of Viscosities of Liquids on Molecular Weight and Molecular Volume. D. T. Lewis and A. R. Morgan. *Chem. Soc., J. pp.* 1341–1345, *Aug.*, 1939.—It is suggested that any equation representing the variation of viscosity of liquids must contain fundamental terms representing temperature, molecular weight, and molecular volume. An equation is derived for chemically related series incorporating these essential terms, and the generality of its application is ascribed to similarity of cohesive pressures in such series. Fluorobenzene is shown to be a normal member of the halogenobenzenes when all factors operative are taken into account. Fused salts give some indication of obeying a similar relation, but lack of reliable parachor data prevents definite conclusions being drawn as to the influence of the molecular volume. [See Abstract 3564 (1938).] AUTHORS.

3924. Viscosity and Molecular Diameter of Azomethane. H. Henkin and H. A. Taylor. *J. Chem. Phys.* 7. *pp.* 829–830, *Sept.*, 1939.—Measurements of the rate of flow of azomethane at low pressures have been interpreted according to Poiseuille's law corrected for slippage to give an average viscosity of $0{\cdot}754 \times 10^{-4}$ poise at 23° C. Assuming a Sutherland constant of 362 from the similar compound β-butylene the molecular diameter of azomethane is found to be 4·54 Å. AUTHORS.

3925. Intermolecular Forces and the Viscosity of Liquids. H. Harms. *Zeits. f. phys. Chem.* 44. *Abt.B.* 1. *pp.* 14–40, 1939.—The connection between viscosity of a liquid and its chemical constitution has been investigated. It is shown that where sufficient knowledge of the intermolecular forces in a liquid is available there is a definite connection between these forces and viscosity. A. J. M.

3926. Viscosity of Gasoline. T. Okaya and M. Hasegawa. *Phys. Math. Soc., Japan, Proc.* 21. *pp.* 347–353, *June*, 1939. *In English.* —The torsional vibration method previously described [see Abstract 4564 (1936)] is employed to measure the viscosity of a gasoline for aeroplane use. This gasoline begins to evaporate at about 40° C. and ceases to exist as a liquid at about 105° C. Density determinations were made at various temperatures between — 8° C. and 38·5° C. by means of a pyknometer, and the viscosity measured at temperatures between — 17° C. and 38·2° C.

The experimental results are shown to fit Andrade's relation between viscosity and absolute temperature. S. W.

3927. Flow and Viscosity of Liquid Helium. H. E. Johns, J. O. Wilhelm and H. G. Smith. *Canad. J. of Research*, 17. *Sect.A. pp.* 149–163, *Aug.*, 1939.—Experiments on the flow of liquid He through glass capillaries ranging in dia. from 0·025 cm. to 0·0036 cm., and with lengths varying from 2 cm. to 26 cm. were carried out. Normal laminar flow was obtained for He I with a viscosity of the order of 10^{-5} c.g.s. units. For He II it was found that the flow could be expressed as the sum of a laminar flow plus an additional pressure-independent flow. The laminar portion, which obeyed Poiseuille's law, gave a viscosity of the order of 10^{-5} c.g.s. units. The pressure-independent portion appears to be partially due to " creep " over the top of the reservoir, but there still remains an additional pressure-independent flow through the capillaries. This additional flow depends among other things on the intensity of illumination and is evidently connected with the " fountain " effect. AUTHORS.

***3928. Effect of Electric Fields on Viscosity of Liquids. O. Kimura.** *Chem. Soc. Japan, Bull.* 14. *pp.* 243–249, *June*, 1939.—A capillary viscosimeter is described to which an electric field can be applied. By means of this viscosimeter, the viscosity of benzene and hexane solution of lauric, myristic, palmitic, and stearic acid and of cetyl alcohol is measured in the presence of an electric field. The viscosity of these solutions generally increases in an electric field, and the stronger the field the greater the increase. The acid with longer chain shows much more effect than one with the shorter. In a solution the effect is proportional to concentration. In lauric acid, the increase of viscosity shows a linear relation. In stearic acid, the increase ceases at a certain voltage. In cetyl alcohol the viscosity increases stepwise and the form of the viscosity-field intensity curve is independent of the nature of solvent. This electroviscose effect is due to the orientation of molecules of solute. The irregularity of curves in stearic acid and cetyl alcohol seems to be due to association. AUTHOR.

3929. Rolling Friction in Elastic Solids. C. Cattaneo. *Accad. Lincei, Atti*, 29. *pp.* 403–411, *April* 15, 1939.—An attempt is made to calculate the coefficient of rolling friction for a cylinder rolling on a rigid plane from the equations of the theory of elasticity. R. P.

3930. Intercrystalline Thermal Currents as Source of Internal Friction. R. H. Randall, F. C. Rose and C. Zener. *Phys. Rev.* 56. *pp.* 343–348, *Aug.* 15, 1939.—An experiment has been designed to detect the contribution of intercrystalline thermal currents to the internal friction of polycrystalline metals. In accordance with theory [see Abstract 504 (1938)] the internal friction is a maximum when the vibration is partly isothermal and partly adiabatic with respect to adjacent grains. By passing in small steps from the nearly isothermal case of very small grain size through maximum internal friction to the nearly adiabatic case of large grain size, one can detect the relative importance of the intercrystalline thermal currents. Such an experiment has been performed on single phase 69–31 brass, with mean grain size ranging in small steps from 0·0006 cm. to 0·4 cm., and with frequencies of 6000, 12000 and 36000$\sim$. Not only was a maximum obtained with the anticipated grain size, but the maximum is of a larger order of magnitude than the background upon which it is superimposed. The internal friction in the extreme isothermal case ($Q > 300000$)

was lower than has ever been observed for metals ; in the extreme adiabatic case it approached the low values obtained for single crystals. This experiment indicates that in annealed nonferromagnetic metals at room-temperature, intercrystalline thermal currents are the dominant cause of internal friction measured at small strains, aside from possible macroscopic thermal currents. AUTHORS.

ASTRONOMY AND ASTROPHYSICS.

COSMOGONY.

See Abstracts 3899, 3938.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

3931. Stationary Solutions of Three-Body Problems. G. Lampariello. *Accad. Lincei, Atti*, 29. *pp.* 298–303, *April* 1, 1939.—Two simple types of motion, *viz.*, that in which the three bodies always lie on one straight line, and that in which they always form an equilateral triangle, were characterised by Levi-Civitá as the only *plane* stationary types of motion, a stationary motion being defined as one for which the energy does not change in first order with an infinitesimal alteration of the initial conditions, keeping the integrals of the motion constant. It is now proved that there are no stationary solutions which are not plane. R. P.

3932. Calculation of Secular Effects by Means of Adiabatic Invariants. G. D. Mattioli. *Accad. Lincei, Atti*, 29. *pp.* 304–312, *April* 1, 1939.—The theory of adiabatic invariants is extended to the case in which the time derivative of the adiabatic parameters depends not only on the time and on the value of the parameters themselves, but also on the configuration of the system. R. P.

3933. Apsidal Librations in Orbits of Small Eccentricity. H. Fabre. *Comptes Rendus*, 209. *pp.* 151–153, *July* 17, 1939.—The author considers the nature of the perturbations caused by the eccentricity of Jupiter's orbit in the orbits of asteroids whose mean motion is commensurable with that of the major planets. The perturbed orbits considered are of zero inclination and of the same order of eccentricity as Jupiter's. In the absence of commensurability, the asteroid perihelion suffers a libration on either side of Jupiter's, but when commensurability is present, zones of instability are produced, in which only temporary perihelion librations can take place. Nodal librations in an orbit of small inclination are impossible. The analogous equations for a field of force corresponding to that between the two components of a double star show that similar zones of instability will be formed. Periastron motion will be direct or retrograde in or near these zones, prolonged librations being impossible. A. HU.

3934. Periodic Solutions of Perturbation Problem. H. Fabre. *Comptes Rendus*, 209. *pp.* 291–293, *July* 31, 1939.—The problem of perturbations of planets and asteroids presents two different aspects according as there does or does not exist between the relevant mean motions a commensurability affecting the eccentricity, the inclination, and the angular velocities of rotation and of secular nodal and perihelion motions. Periodic

solutions are of no interest where commensurability is not present, because the periods involved are so long and the calculations, with the necessary approximations, so complicated; the ordinary perturbation theory suffices for this case. With simple commensurability, however, and particularly with asteroids perturbed by Jupiter, such solutions are useful [see Abstract 3573 (1939)]. Cases where the inclination is zero have already been treated; the author now extends his work to cases of appreciable inclination. The perturbation of perihelion longitude is found to be practically the same as for zero inclination, so that the previous solutions remain valid up to inclinations of 12° to 15°. A. Hu.

3935. Dynamics of Double Star Systems and Stellar Density Condensations. Z. Kopal. *Zeits. f. Astrophysik*, 18. 4–5. *pp.* 272–283, 1939.—The paper deals with the dynamics of close binary systems the components of which can be regarded as invariable in form. It is shown that such bodies describe orbits which, if their eccentricities are not too large, exhibit an advance of the longitude of periastron of a given amount. The ellipsoidal components are free to display in the orbital plane two modes of librations. The amplitudes of the short-periodic librations (their periods being slightly different from that of the orbit) are found to be proportional to the orbital eccentricity and vanish for circular orbits.

Author.

See also Abstracts 3875, 3940,

LATITUDE AND LONGITUDE.

3936. Measures of Personal Equation in the Method of Equal Altitudes. E. Buchar. *Bull. géodésique*, *No.* 60. *pp.* 329–345, *Oct.–Nov.–Dec.*, 1938.—An instrumental device for mechanically determining personal equation simultaneously with, but independently from, stellar observations with an almucantor was previously described by the author [see Abstract 5200 (1933)]. The present paper is an analysis of results for three observers at 20 different stations situated in the Czeckoslovak triangulation system. The personal equations of all three observers are of the order $-0^s{\cdot}1$, corresponding to retarded observation. The absolute equations were checked by assuming a longitude for one station as independently known from transit observations. The agreement was within $0^s{\cdot}03$. The relative personal equations referred to one of the observers coincide in general with those deduced from astronomical observations. Applying the personal equations reduced the differences in longitude as determined by three observers to zero. The conclusion is that the apparatus enables the absolute personal equation of an observer to be determined.

E. M. W.

3937. Simultaneous Determination of Longitude, Latitude, and Azimuth. S. Hayne. *Bull. géodésique*, *No.* 60. *pp.* 390–394, *Oct.-Nov.–Dec.*, 1938.—*In German.*—Separate observations of longitude, latitude, and azimuth in the field are laborious and time-wasting. Transit observations on pairs of stars in the meridan give accurate time results with a minimum of computation ; in combination with measures of the bearing of a terrestrial mark, the method yields accurate azimuth results ; whilst for latitude determinations the method can be adapted to measuring meridian zenith-distance differences. The desiderata for a specially-constructed universal instrument are outlined, and its method of use described on a programme whose selection is discussed. The method of reduction and the accuracy of the results are given. A 3- or 4- fold saving

of work and time is claimed in comparison with previous methods. [See also Abstract 3920 (1939).] A. Hu.

NEBULÆ.

3938. Expansion of a Nebula. D. N. Moghe. *Calcutta Math. Soc., Bull.* 31. *pp.* 19–23, *March*, 1939.—Sen's equation of motion for a free particle outside a mass-centre [see Abstract 2323 (1938)] is shown to imply that space is filled with matter of negative density. It is shown that this difficulty is overcome if the invariant density is regarded as constant and that Sen's numerical calculations are not altered. In reply **N. R. Sen** points out that his equation is approximate only and that Moghe's negative density arises when the problem, which is really non-statical, is transformed into a statical problem. G. C. McV.

3939. Physical Processes in Gaseous Nebulæ. Part VII. Transfer of Radiation in Lyman Continuum. J. G. Baker, L. H. Aller, and D. H. Menzel. *Astrophys. J.* 90. *pp.* 271–280, *Sept.*, 1939.—The differential equations for the transfer of radiation in the Lyman continuum are derived. In order to take into account the varying quality of the radiation as it passes through the nebula and also the variation of the electron temperature, it is necessary to consider the transfer in each element of the continuum rather than to treat the continuum as a single level. The equation of transfer, as written down for a particular frequency in the continuum, therefore contains a term that describes the "interlocking" between the elements of the continuum. The application of these equations to a numerical example is deferred to a later paper. [For Part VI see Abstract 2767 (1939).] Authors.

See also Abstract 3941.

PLANETS.

3940. Relativistic Planetary Orbits. T. T. Vescan. *Comptes Rendus*, 209. *pp.* 149–151, *July* 17, 1939.—Solar radiation is assumed to reduce the mass μ of the sun thus: $\mu = \mu_0 e^{-qt}$, where $\mu_0 = 2 \times 10^{33}$ gm. and $q = 3 \times 10^{-21}$, t being in sec. This reduces to $\mu = \mu_0 (1-qt)$, since the decrease is so small. The effect on planetary orbits is discussed, and it is shown that the major axes of the relativistic "rosettes" increase by amounts that are theoretically interesting but experimentally insignificant. The numerical results given show that the fractional increase per revolution ranges from 3×10^{-14} for Mercury to 4×10^{-11} for Pluto. A. Hu.

See also Abstracts 3933, 3934.

STARS.

3941. Observations with Nebular Spectrograph of McDonald Observatory. Part III. O. Struve, C. T. Elvey, and W. Linke. *Astrophys. J.* 90. *pp.* 301–308, *Sept.*, 1939.—A series of 30 spectrograms in various parts of the sky reveal a number of new emission regions. Attention is called to the fact that [OII] 3727 is relatively strong in Monoceros and Canis Major and weak in Sagittarius, Scorpius, and other regions situated in the summer Milky Way. The large star clouds in Sagittarius and neighbouring regions are relatively poor in emission. [For Part II see Abstract 2407 (1939).] Authors.

3942. Masses of Stars. S. Gaposchkin. *Roy. Astron. Soc., Canada, J.* 33. *pp.* 233–240, *July–Aug.*, 1939.—There exist 122 single determinations of stellar mass; 74 from eclipsing stars, 41 from visual

binaries, and 7 from the relativity theory. Indirect determinations of the masses for eclipsing systems by the writer have increased the number of individual known masses to over 500. From this material it is concluded that the range in masses is 1 to 200; if the heaviest of the Trumpler stars is included, the range is 1 to 2000. AUTHOR.

3943. Space Reddening in the Galaxy. J. Stebbins, C. M. Huffer and A. E. Whitford. *Astrophys. J.* 90. *pp.* 209–229, *Sept.*, 1939. —The space reddening was determined from the colours of 1332 B stars measured photoelectrically at Madison and Mount Wilson. From spectrophotometric measures of reddened B stars the selective absorption varies approximately as λ^{-1}. On the basis of this law the total visual and photographic absorptions are, respectively, seven and nine times the colour excess. When allowance is made for interstellar absorption, the early B stars are found to be intrinsically nearly 1 mag. brighter than previously assumed. The correlation between colour excess and the intensities of interstellar lines is as close as the correlation between the intensities of the different lines in the same stars. The reddest B stars are all near the galactic circle, and there are more of them toward the centre than toward the anticentre of the galaxy. Near the centre there is more absorption on the north side than on the south side of the galactic circle. The B stars in several bright clouds are all slightly coloured, showing that even the brightest parts of the Milky Way are affected by absorption. The absorption near the sun is given by the colours of bright B stars and of A stars near the north pole of rotation. The absorption near the pole at less than 300 parsecs is confirmed. In general the absorbing clouds are near the galactic plane, but they are so irregular in distribution that the conception of a uniform layer with a constant coefficient of absorption is no longer tenable. AUTHORS.

3944. Doublet Ratio of Interstellar H and K and Absolute Magnitudes of Wolf-Rayet Stars. R. F. Sanford and O. C. Wilson. *Mt. Wilson Observat., Contrib. No.* 613. *Astrophys. J.* 90. *pp.* 235–243, *Sept.*, 1939.—The total absorptions of the interstellar Ca II lines, H and K, have been measured in 40 O and B stars with weak Hϵ and in 18 Wolf-Rayet stars. The difficulty so often encountered in measuring the total absorption of H in the presence of strong Hϵ in absorption has therefore been largely obviated, and it is hoped that these measures are an improvement upon earlier ones. K/H appears to be approximately 2 for very weak lines and to decrease, on the average, as lines of greater strength are considered, reaching 1·56 for H = 0·4 Å, with little apparent tendency to diminish thereafter. 24 stars (in the given table) provide measures of the total absorptions of the interstellar D2 and D1 of Na I. The mean D2/K and D1/H derived therefrom are 1·63 and 2·18 respectively, which closely check earlier results, 1·6 and the tentative value 2·1, respectively. The curve which relates distance with K-line intensity has been used to derive the distances of the 18 Wolf-Rayet stars from which mean visual absolute magnitudes for 6 stars of the carbon sequence and 12 of the nitrogen sequence have been derived. They are − 2·8 and − 2·1 respectively. Plausible values of temperature, together with the authors' derived absolute magnitudes and what appears to be a reasonable allowance for the contribution of bright bands to the apparent magnitudes, give masses approximately 30 times that of the sun. The assumptions and guesses involved make such values highly speculative, even though the mass-luminosity relation itself is unqualifiably accepted. AUTHORS.

3945. Intercomparison of Doublet Ratio and Line Intensity for Interstellar Na and Ca. O. C. Wilson. *Mt. Wilson Observat., Contrib. No.* 614. *Astrophys. J.* 90. *pp.* 244–248, *Sept.*, 1939.—If the observed decrease in the doublet ratios K/H and D2/D1 in passing from weak to strong lines is a manifestation of Doppler effect (curve of growth), it is shown that the mean small-scale velocity of the Ca ions must be about three times that of the Na atoms. This difference is probably difficult to justify physically, and no solution is offered. The question of the relative numbers of Na atoms and Ca ions in space is discussed briefly. AUTHOR.

3946. Surface Temperatures of A0 Stars. D. Barbier and D. Chalonge. *Comptes Rendus*, 209. *pp.* 293–295, *July* 31, 1939.—On the hypothesis of local thermodynamical equilibrium, it is necessary to know something of the absorption coefficients of stellar matter in order to derive temperatures from observational results. Direct measures can, however, be made on radiation from the stellar limb (in eclipsing variables suffering total eclipse) or where the absorption coefficient is sufficiently great for the surface to radiate effectively as a black body. In eclipsing variables for which the latter condition holds, the colour temperature should be independent of phase and identical with the surface temperature, whether or not the eclipse is total. Observations of Algol close to principal minimum show that the colour temperature below 3700 A remains constant throughout eclipse and therefore represents the surface temperature. Extending this result to all stars with strong continuous H absorption, a list of surface temperatures is given for stars of types B8-A5. The value 10500° for A0 stars corresponds to an effective temperature of 12500°. A. HU.

3947. Effective Stellar Temperature Scale. Z. Kopal. *Astrophys. J.* 90. *pp.* 281–288, *Sept.*, 1939.—The effective temperatures of eclipsing binaries, divided into groups of similar spectra, have been studied on the basis of their mean parallaxes derived from their proper motions and radial velocities. The main result is that the effective temperatures of B- and A-type components of eclipsing binary systems are found to be about 10% lower than those given by Kuiper's recent effective-temperature scale, based primarily on simple stars. The results for a few stars for which individual trigonometric parallaxes are available lead to similar conclusions. AUTHOR.

3948. Continued Gravitational Contraction. J. R. Oppenheimer and H. Snyder. *Phys. Rev.* 56. *pp.* 455–459, *Sept.* 1, 1939.—When all thermonuclear sources of energy are exhausted a sufficiently heavy star will collapse. Unless fission due to rotation, the radiation of mass, or the blowing off of mass by radiation, reduce the star's mass to the order of that of the sun, this contraction will continue indefinitely. In the present paper are studied the solutions of the gravitational field equations which describe this process. General and qualitative arguments are given on the behaviour of the metrical tensor as the contraction progresses: the radius of the star approaches asymptotically its gravitational radius; light from the surface of the star is progressively reddened, and can escape over a progressively narrower range of angles. An analytic solution of the field equations confirming these general arguments is obtained for the case that the pressure within the star can be neglected. The total time of collapse for an observer comoving with the stellar matter is finite, and for this idealised case and typical stellar masses, of the order of a day; an external observer sees the star asymptotically shrinking to its gravitational radius. AUTHORS.

3949. Motion of Galactic System among Nebulæ. E. Hubble. *Frank. Inst., J.* 228. *pp.* 131–142, *Aug.*, 1939.—The extra galactic nebulæ now form the most fundamental reference frame for stellar motions. The observable data are the radial velocity shifts. The author discusses fully the successive steps followed in the separation of different components making up the total motions. The removal of the systematic component of the red shift leaves residuals which reflect only the solar motion with respect to the nebulæ. The need for more exact knowledge of the nebular distances is emphasised. The conclusions reached are (1) that the apex of the solar motion is in the neighbourhood of galactic longitude 63° and latitude + 35°, with a velocity of the order of 300 km./sec., and (2) that the motion of the galaxy among the nebulæ is of the order of 150 km./sec. in the general direction of the north galactic pole. Finally a "local group" is discussed, consisting of a dozen nebulæ of which the galaxy is one. The conclusion is either that the galactic system with its satellites is a triple nebula in the general field and is approaching the small group in its vicinity, or that the law of red shifts does not operate within a physically connected system such as the local group. E. M. W.

3950. Eclipsing Binary VV Cephei. V. A. Goedicke. *Observatory*, 62. *pp.* 197–213, *Aug.*, 1939.—The author describes this eclipsing binary (period 20 yr.), consisting of a supergiant M star (the largest known) and a B star; its density and those of its own atmosphere, and of a stationary one, all three being in decreasing stages of vacuum, its spectra and other qualitative information are given; its quantitative discussion is difficult through complexities due to many causes. He discusses its orbit and its absolute dimensions, assuming (1) a sharp and (2) a diffuse photosphere, the temperatures and compares the two orbits. Of the atmospheres he discusses (1) the stellar, (2) the hydrogen, (3) the ionised iron. He finds little additional evidence as to the origin of ionised Ca emission, since measurable features are not found near eclipse. It was necessary to postulate a strong emission region closely surrounding the B star to explain the observations. A. S. D. M.

3951. S Sagittae. A. L. Bennett. *Astrophys. J.* 90. *pp.* 289–293, *Sept.*, 1939.—S Sagittae was observed from April 24 to Nov. 14, 1938, with the infra-red photometer on the Loomis telescope. Energy of effective wavelength near λ 8000 was used. The range of variation is $0^m \cdot 459$, the second maximum is very nearly equal to the first, and minimum occurs 2·35 days before maximum. AUTHOR.

3952. Loreta's Hypothesis Concerning R Coronae Borealis. J. A. O'Keefe. *Astrophys. J.* 90. *pp.* 294–298, *Sept.*, 1939.—It is shown that the shape of the light-curve of R Coronae Borealis and its spectral variations at minimum can be accounted for by supposing it to eject matter which condenses at a considerable distance and forms obscuring clouds. The solid matter is believed to be principally carbon. This hypothesis is shown to be consistent with physical principles. AUTHOR.

See also Abstracts 3935, 3992, 4097.

SUN.

3953. Altitude of Chromosphere in 1938 and Solar Cycle. G. Abetti. *Accad. Lincei, Atti.* 29. *pp.* 271–273, *April* 1, 1939.—The mean altitude of the chromosphere in 1938 is found to be 10·31″ according to the observations made in Arcetri. It has slightly diminished, by 0·21″, as compared with 1937. The total area of prominences has increased by

331 units in 1938. The increasing activity of the upper and middle chromosphere has been confirmed by the preliminary examination of the spectroheliograms taken with Ca and H-light. L. K.

3954. Tables of Sunspot-Frequency for 1749–1938. W. Brunner. *Terr. Mag.* 44. *pp.* 247–256, *Sept.*, 1939.

3955. Intensities of Sunspots from Centre to Limb in Light of Different Colours. R. S. Richardson. *Mt. Wilson Observat., Contrib. No.* 612. *Astrophys. J.* 90. *pp.* 230–234, *Sept.*, 1939.—The ratio of intensity, spot to disc, was determined for 13 different sunspots on 25 days during the summer of 1938. Observations were made only on large stable spots when the seeing was 5 or better on a scale of 10. Spectral regions nearly free from lines were selected at $\lambda\lambda$4100, 5100, 5800, and 6600. The observations can better be represented on the assumption that the spot is in radiative, rather than in adiabatic, equilibrium. An effective temperature of 4300° K. was found for the umbra, about 500° lower than that commonly given. AUTHOR.

See also Abstract 3959.

GEOPHYSICS.

GEODESY.

See Abstracts 3920, 3937.

GEOPHYSICS, APPLIED.

See Abstract 3967.

HYDROSPHERE, PHYSICS OF THE.

3956. Refractive Index of Sea Water. Y. Miyake. *Chem. Soc. Japan, Bull.* 14. *pp.* 239–242, *June*, 1939.—Refractive indices of sea water of various chlorinities were measured and the following empirical formula was obtained : $n_D^{25} = 1{\cdot}33249_7 + 0{\cdot}000334\,\mathrm{Cl}$. An assumption that the refraction of sea water is a summation of the individual refractions of pure water and dissolved salts, was proved both experimentally and theoretically. AUTHOR.

LAND, PHYSICS OF THE.

3957. Gravity Anomalies and Subterranean Mass Distribution. Part III. C. Tsuboi. Part IV. C. Tsuboi, T. Kaneko, S. Miyamura and T. Yabasi. *Tokyo Univ. Earthquake Research Inst., Bull.* 17. *pp.* 351–410, *June*, 1939.—*In English.*—In Part III, the author applies the method developed earlier [see Abstract 4024 (1938)] to determine the relation between gravity anomalies and the subterranean mass in the following cases : African Rift Valleys, Honsyû in Japan, and Dutch East Indies. In Part IV the method is applied to the U.S.A. and the conclusions agree generally with the results of earlier workers. W. A. R.

3958. Theory of Mountain Building. D. Griggs. *Am. J. Sci.* 237. *pp.* 611–650, *Sept.*, 1939.—A theory of mountain-building by cyclic convection, thermal and not chemical in origin, is synthesised from : (1) the suggestions of Holmes, (2) the mathematical analyses of Pekeris

Vening Meinesz, and Hales, (3) the writer's experiments on solid flow of rocks, (4) thermal experiments and calculations, and (5) a dynamically similar model to demonstrate the action of cyclic convection currents. The way in which this theory predicts the intermittence of mountain-building is discussed, and its ability to explain the diastrophic cycle. Previous theories of orogenesis are briefly reviewed and some of their points of inadequacy are discussed. AUTHOR.

See also Abstract 3970.

METEOROLOGY.

3959. U.V. Rays and Solar Cycle. J. R. Ashworth, *Manchester Lit. and Phil. Soc., Mem.* 83. *pp.* 81–86, 1938–1939.—The results of observations carried out during the period 1932–38 at Rochdale are examined. The method of observation is fully described. The rays investigated form a group around 3600 Å, and a wider group from the middle of the visible to the blue end. The ratios of the annual totals of the two classes are obtained and graphed. Low values occur around the time of sunspot minimum and high values at sunspot maximum. Comparison with the ionisation curve of the E-layer at corresponding times as found by Appleton, shows that both curves are similar. The possible effect of pollution is investigated by making sets of parallel observations in districts free from industrial pollution. Examination of the daylight rays alone indicates an inverse effect to that of the u.v. rays with sunspot variation. On this point, however, the author considers that a longer period is necessary before a general rule can be established. But whatever the cause of the variability, account of it must be taken in dealing with the ratio of u.v. to daylight. A. E. M. G.

3960. Weather Prediction. *Nat. Inst. Sci. India, Proc.* 5. 1. *pp.* 43–165, 1939.—This symposium comprises 10 papers dealing with various aspects of weather forecasting attention being focussed in most cases on the problem as it faced the Indian meteorologist. A brief discussion took place on each paper.

The symposium is preceded by an "Introductory Address" by **C. W. B. Normand** (*pp.* 43–47).

"Seasonal Forecasting in India," by **S. R. Savur** (*pp.* 49–60).—In a historical section reference is made to the method used by Walker in applying correlation coefficients in world weather to seasonal forecasting. A further development is in the use of Normand's performance test. Periodicities have little practical importance. Baur's method for ten-day forecasts is mentioned and an example given. A table of factors used in Indian seasonal forecasts is supplied.

"Medium-Range Weather Forecasts," by **S. Basu** (*pp.* 61–73).—The general basis of Baur's 10-day forecasts in Germany is described. Four related factors occur :— The average pressure gradient in the lower stratosphere, the average temperature gradient in the troposphere, the general flow and steering. Correlations are obtained and multiple correlation tables are constructed. With these, synoptic considerations are used for the forecasts. The basic principles of Multanovsky's method in Russia are described. Three groups of trajectories of pressure maxima are identified and the associated weather is depicted to form composite maps. The signs of the start and threat symptoms of a new phase are explained and the success and application of the methods are discussed.

"Air-Mass Analysis and Short Period Weather Forecasting in India," by **S. N. Sen and H. R. Puri** (*pp.* 75–91).—A tabular classification of extra-tropical, tropical and equatorial air masses and transitional types is given showing the source, track, character and season of dominance for each. The seasonal growth of air masses, and the development of heterogeneity in them is considered. Factors used to identify air masses include arbitrary conditions and surface temperatures, abnormalities, and horizontal gradients. The mechanism of weather over India is explained by the presence of four general deformation fields with linear and angular oscillations. Examples are given of the method used. Forecasts up to five days ahead are thus possible.

"Forecasting of Nor'westers in Bengal," by **S. K. Pramanik** (*pp.* 93–99).—The nor'westers are severe thunderstorms, often tornadic in character with funnel-shaped clouds which occur mainly with north-westerly winds in the transition seasons. The explanations given in earlier papers are reviewed and criticised. Finally four necessary conditions for afternoon nor'westers are supplied which can be used in forecasting.

"Upper Air Data and Weather Forecasts," by **K. R. Ramanathan** (*pp.* 101–106).—The growth of upper air work in India is first described. The objects of collecting upper air data are for statistical analysis in climatological maps, obtaining ideas regarding general and local circulations and special weather phenomena, providing current information for forecasts and locating fronts and air masses. Notes are given regarding the formation of fronts at different seasons.

"Latent Instability in the Atmosphere and its Consequences," by **N. K. Sur** (*pp.* 107–115).—Latent instability in the atmosphere is illustrated with the help of the T.ø diagram and its development into convective instability explained. It occurs in India with the incursion of oceanic air of tropical or equatorial origin but the season varies from one part of India to another. Examples are quoted in which upper air ascents were used for storms forming in the Indian seas in pre- and post-monsoon seasons and for depressions forming in the Bay of Bengal during the southwest monsoon season when latent instability occurred. The use of this criterion in forecasting is discussed.

"Rainfall Due to Winter Disturbances and Associated Upper Air Temperatures over Agra," by **S. P. Venkiteshwaran** (*pp.* 117–121).—Data from sounding balloons at Agra over the period Jan.–April, 1931, were grouped into four periods which showed consecutive variations of humidity in the upper air. The rainfall at all provincial stations on these days was also plotted. It is shown that the temperature distribution over Agra is an indication of the rainfall distribution over the Western Himalayas and the Punjab.

"Upper Air Data and Daily Weather Forecasts," by **S. K. Pramanik** (*pp.* 123–128).—Examples were given to illustrate the use in forecasts of upper winds obtained from pilot balloon ascents. The origin and thus, properties of the air can be traced by using this information. Difficulties arise if vertical movement of the air occurs.

"Weather Forecasting for Aviation with Special Reference to Local Forecasts," by **P. R. K. Rao** (*pp.* 129–138).—Regional, route and local forecasts are considered and the factors to be dealt with include ground and upper winds, cloud, visibility, adverse weather phenomena, and the location, slope and travel of fronts and adjacent air masses. Examples are given of each type. The use of the tephigram, latent and convective

instability and the methods used in forecasting the development and clearance of cloud and the onset of fog are discussed.

"Kinematical Methods in Weather Forecasting," by **S. K. Banerji** (*pp.* 139–165).—The principle of the method developed by Dedebant and Petterssen is explained. Mathematical relations are developed for the (*a*) velocity and acceleration of a characteristic curve, (*b*) acceleration of isobars, (*c*) motion of the centre of a cyclone or an anticyclone, (*d*) motion of trough lines, (*e*) motion of fronts, (*f*) deepening and filling up of a depression, and (*g*) methods of numerical calculation. These relations are then applied to several examples of Indian weather charts. R. S. R.

3961. Auroral Work in Southern Norway in the Year 1938. C. Störmer. *Terr. Mag.* 44. *pp.* 233–242, *Sept.*, 1939.

***3962. Theory of Ceiling Projector. W. E. K. Middleton.** *J.O.S.A.* 29. *pp.* 340–349, *Aug.*, 1939.—The ceiling projector is a small searchlight used to measure cloud heights at night. The elementary geometry of the measurement is stated, and expressions are developed for the apparent brightness of the spot of light under various atmospheric conditions, and for the total flux density from the spot at the observing station. Some remarks on the visibility of the spot are appended. AUTHOR.

***3963. Rideal Absorption Hygrometer. H. W. Harkness.** *Rev. Sci. Instruments*, 10. *pp.* 237–240, *Aug.*, 1939.—The Rideal absorption hygrometer has been studied with a view to its possibilities as a laboratory instrument for the measurement of the hygroscopic condition of gas in small and confined spaces. The theoretical errors due to absorption of moisture upon the containing walls of the apparatus, and the error introduced by the presence of stagnant air in the connecting tubes of the hygrometer, have been derived. The nature of the theoretical error due to adsorption is supported by experiments. The temperature changes occurring in the hygrometer, during the process of an experiment, have been followed and corrections applied. The results, thus corrected, show reasonable agreement with the published data upon the saturated vapour pressure of water. Finally a hygrometer has been built suitable for immersion in a thermostat. Measurements with this instrument have been compared with reliable dew point determinations taken in a hygrostat of special design. AUTHOR.

SEISMOLOGY.

3964. Transmission of Rayleigh Waves through an Inner Stratum of the Earth. K. Sezawa and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 17. *pp.* 179–189, *June*, 1939. *In English.*—The velocity of boundary waves ranges between the velocity of distortional waves in the stratum and that in the outer media. When the displacement distribution of the waves is symmetrical with respect to the middle plane of the stratum, there is only one dispersion curve ; if unsymmetrical, there may, under certain circumstances, be a number of dispersion curves. These curves are discussed in some detail. W. A. R.

3965. Packet Velocity of Dispersive Elastic Waves of Irregular Form. K. Sezawa and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 17. *pp.* 208–232, *June*, 1939. *In English.*—Even if the wave form be irregular, the energy of the waves is transmitted with a special group velocity. If the sinusoidal components composing the irregular waves have different group velocities, it is likely that the centroid of the energy of the wave packet will be transmitted with the group velocity that

orresponds to the waves of infinite length involved in the irregular vaves. If the group velocity differs with difference in length of the inusoidal waves (even if the disturbance be of sine-form of finite extent), he centroid of the disturbance is still transmitted with the group velocity of sinusoidal waves of infinite length. W. A. R.

3966. Variation of Seismic Velocities within a Simplified Earth Model, in accordance with the Theory of Finite Strain. F. Birch. *Seismological Soc. of America, Bull.* 29. *pp.* 463–479, *July*, 1939.—Murnaghan's theory of finite strain has been applied in an approximate form to a study of the density and velocity variations in a simplified model of the earth outside the core, the model consisting of two homogeneous layers, each at a uniform temperature. Following Jeffreys, the layers are separated by a first-order discontinuity at a depth of 474 km. About 474 km., the variations of the velocities in this model are shown to be practically the same as Jeffreys' " observed " values. The main features of the velocity-depth curves are represented with fair precision down to the core. This is, of course, no longer true if the velocities are supposed to vary continuously through the 474-km. level. Whichever supposition be held, if the rate of change of velocity immediately below 474 km. is to be reproduced closely, a gradual change of composition must be introduced. The variation of density upon the two-layer supposition is very close to that derived by Jeffreys and by Bullen by numerical integration of the " observed " velocities, on the supposition of adiabatic compression of homogeneous layers. The validity of their method is shown to depend upon the existence of a small temperature gradient, or of compensating factors which cannot be evaluated. It is suggested that a more rigorous solution of the equations of motion derived from the theory of finite strain might prove of value in interpreting the oscillatory character of seismic records, as well as the direction of the ground motion associated with various wave types. Author.

3967. Oscillations of Mountainside of Vesuvius Coinciding with Periods of Eruptive Activity. G. Imbô. *Accad. Lincei, Atti*, 29. *pp.* 422–426, *April* 15, 1939.—Measurements have been taken of the apparent inclination in two directions of a pendulum of 16 m. length, suspended in the Vesuvian observatory. In several instances oscillations of a period of about 2 hr. and amplitudes of about $0{\cdot}5''$ were found, which always coincide with periods of vulcanic activity. The oscillations begin some 10 hr. before the actual eruption, so that this method provides means of predicting eruptions. R. P.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

3968. Atmospheric Disturbances due to Thundercloud Discharges. Part I. F. W. Chapman. *Phys. Soc., Proc.* 51. *pp.* 876–894, *Sept.*, 1939.—The various ways of delineating photographically the random transient changes in the earth's electric field by means of a kathode-ray oscillograph are described together with a convenient method of recording the time history of all the disturbances that arise from a thundercloud discharge. An interpretation of these records and observations on the rate of change of field follows. It is found that a positive field change is almost invariably initiated by a volley of pulsations which is succeeded by a sequence of violent changes of similar characteristic structure and indicates the discharge of negative electricity from the cloud to ground by the familiar intermittent lightning flash. The results obtained give the

magnitude and nature of the currents involved in the various stages of the flash. Negative field changes observed under the same conditions are recorded as a relatively slow variation of the field carrying minor pulsations and provide evidence relating to the different nature of discharges within the cloud. Following an analysis of the field change due to a component stroke of the intermittent flash an explanation is given to account for the rate of dispersal of charge in the thundercloud towards the end of the lightning stroke which requires a conductivity of the order of 10^2 e.s.u. The records obtained at great distances from the storm centre show that the strongly radiated pulse from each lightning stroke is accompanied by a succession of echoes due to multiple reflections between the ionosphere and the ground. AUTHOR.

3969. Photographs of Unusual Discharges during Thunderstorms. R. E. Holzer and E. J. Workman. *J. of Applied Physics*, 10. *pp.* 659–662, *Sept.*, 1939.—The known photographs of an unusual type of discharge occurring in intense thunderstorm fields principally near ground objects are described and discussed. A possible explanation of the discharges is suggested. AUTHORS.

3970. "Free-Air" Reduction of Local Magnetic Anomalies. T. Nagata. *Tokyo Univ. Earthquake Research Inst., Bull.* 17. *pp.* 411–422, *June*, 1939. *In English.*—The method given in an earlier paper [see Abstract 4022 (1938)] cannot be applied directly to the results of observations on the surface if the undulation of the earth's surface cannot be taken as a horizontal plane and Tanakadate's method of height correction is not always applicable. A method is given for reducing the observed values on an undulating surface to those on a horizontal plane with the aid of Fourier's analysis of the undulation in two-dimensional cases. The method is checked by an example where the subterranean structure is already known. R. S. R.

See also Abstract 4154 and
2084B. Artificial Lightning Strokes on Models. A. Matthias.

RADIOACTIVITY.

3971. γ-Rays of ^{13}N. Y. Watase and J. Itoh. *Phys. Math. Soc., Japan, Proc.* 21. *pp.* 389–394, *July*, 1939. *In English.*—With the use of a magnetic spectrometer the spectrum of secondary electrons emitted from carbon and lead plates by γ-rays of ^{13}N was investigated. The existence of the γ-ray 285 ± 10 ekV in energy was confirmed. The analysis of the β-ray spectrum is discussed. AUTHORS.

3972. Neutron Production and Absorption in U. H. L. Anderson, E. Fermi and L. Szilard. *Phys. Rev.* 56. *pp.* 284–286, *Aug.* 1, 1939.—An experimental investigation has been carried out to determine whether more neutrons are emitted from U on bombardment with slow neutrons than are absorbed. An increased activity of about 10 % was found, which, it is postulated, corresponds to an emission of 1·5 neutrons per original neutron when all effects are taken into account. The possibility of a nuclear chain reaction has been discussed but no definite conclusion has been reached. G. O. B.

3973. Further Disintegration Products from Bombardment of U with Neutrons. O. Hahn and F. Strassmann. *Naturwiss.* 27. *pp.* 529–534, *Aug.* 4, 1939.—It has been found that isotopes of Cs, Rb, Xe, Kr, I, and Br are formed as disintegration products of U when bombarded with neutrons. The processes involved in the formation of these nuclei are discussed, and the half-life periods have been determined. A. J. M.

3974. Disintegration of Th. O. Hahn, F. Strassmann, and S. Flügge. *Naturwiss.* 27. *pp.* 544–547, *Aug.* 11, 1939.—In addition to Ba with half-life 14 min., formerly investigated, Ba with half-life 300 hr. and 86 min. I with half-life 2·3 hr. from Te of half-life 66 hr., and Mo with half-life about 66 hr. have been discovered among the disintegration products of Th bombarded with neutrons. A. J. M.

3975. Nuclear Energy Levels in B^{10}. P. G. Kruger, F. W. Stallmann and W. E. Shoupp. *Phys. Rev.* 56. *pp.* 297–302, *Aug.* 15, 1939.—5000 stereoscopic pictures of electron tracks in a cloud chamber yielded 665 Compton electrons from a thin mica foil and 76 ± electron pairs formed in the gas in the chamber. These data indicate 31 lines in the γ-ray spectrum of B^{10}. Nine energy levels account for the observed lines in a satisfactory manner, and are not in disagreement with the neutron spectrum from the same reaction. An attempt to correlate the observed energy levels with those predicted by theory leads to the following suggested classification: $^3S_1$ as the ground state (relative energy zero); $^3D_{123}$ at 0·26, 0·50 and 0·61; ^1S at 1·44; ^1D at 1·93; ^3D at 2·92; ^1D at 3·64; and ^3F at 4·73 eMV. AUTHORS.

3976. Induced Radioactivity in Cd and In. J. M. Cork and J. L. Lawson. *Phys. Rev.* 56. *pp.* 291–294, *Aug.* 15, 1939.—The artificial activation of Cd and In now yields at least three radioactive isotopes of Cd and eight radioactive isotopes of In. The probable masses of several of these isotopes have been determined. In Cd bombarded with deuterons two chain reactions are observed in which the active Cd decays to radioactive In. These are Cd (56 hour) to In (4·5 hour), and Cd (3·75 hour) to In (2·1)hour. Evidence is presented for believing that a new 65-hour γ-radiation is due to an excited state of a normally stable In isotope of mass 113. The energies and decay constants of many of the radiations have been accurately measured by means of a magnetic spectrometer of high resolving power. AUTHORS.

3977. Proton Activation of In and Cd. S. W. Barnes. *Phys. Rev.* 56. *pp.* 414–421, *Sept.* 1, 1939.—Indium activated by 7·2 eMV protons exhibits two activities, one due to In^{115*} and one due to Sn^{113}. The other two activities previously reported have been shown to be due to impurities. Sn^{113} has a half-life of about 100 days and decays by K electron capture emitting In K X-rays. An active In of 105 ± 10 min. half-life with a γ-ray of 0·39 eMV has been chemically separated from an aged Sn^{113} sample. An exactly similar In has been formed by proton bombardment of Cd which suggests the assignment of this activity to an excited state of stable In^{113}. The absence of Cd K X-rays indicates that In^{113*} decays to In^{113} with the emission of the 0·39-eMV γ-ray. In addition bombarded Cd shows the expected In isotopes In^{111} 20 min. (+), In^{114} 48 days (—) and In^{116} 54 min. (—). A positron emitter of 65 ± 5 min. half-life with a maximum positron energy of 1·6 ± 0·3 eMV is found and tentatively assigned to In^{110}. Activities of 72 sec. (—) and 2·7 ± 0·2 days (—) the latter accompanied by γ-rays of 170 and 250 ekV are ascribed to isomeric states of In^{112}. AUTHOR.

3978. Coincidences Between β- and γ-Rays in Mn. L. M. Langer, A. C. G. Mitchell and P. W. McDaniel. *Phys. Rev.* 56. *pp.* 422–425, *Sept.* 1, 1939.—With two reliable high speed counters in a coincidence circuit of resolving time, $\tau = 3{\cdot}4 \times 10^{-7}$ min., coincidences have been recorded between β- and γ-radiation from Mn^{56} (148 min.) formed by slow neutron capture. By interposing various thicknesses of Al between the source and the β-ray counter, the ratio of β-γ coincidences to single β-counts was observed as a function of the energy of the β-rays. The number of coincidences per β-ray was larger when electrons of all energies were striking the β-ray counter than when only electrons of high energy were recorded. Coincidences were still recorded when only the high energy β-rays were entering the counter. In addition γ-γ coincidences were found. From these experiments it is concluded that Fe^{56} is formed in two excited states from the disintegration of Mn^{56} and that one γ-ray per disintegration is associated with the high energy group and about two γ-rays per disintegration with the low energy group. AUTHORS.

3979. Mechanism of Nuclear Fission. N. Bohr and J. A. Wheeler. *Phys. Rev.* 56. *pp.* 426–450, *Sept.* 1, 1939.—On the basis of the liquid drop model of atomic nuclei, an account is given of the mechanism of nuclear fission. In particular, conclusions are drawn regarding the variation from nucleus to nucleus of the critical energy required for fission, and regarding the dependence of fission cross-section for a given nucleus on energy of the exciting agency. A detailed discussion of the observations is presented on the basis of the theoretical considerations. Theory and experiment fit together in a reasonable way to give a satisfactory picture of nuclear fission. AUTHORS.

3980. Chemical Methods of Concentrating Radioactive Halogens C. S. Lu and S. Sugden. *Chem. Soc., J. pp.* 1273–1279, *Aug.*, 1939.—When organic halides are irradiated with neutrons a considerable amount of the radioactive halogen formed can be separated by extraction with suitable reagents (Szilard and Chalmers, *Nature*, 1934, 134, 462). In the present paper a quantitative study of this phenomenon has been made, a variety of halides and a number of reagents to extract the radioactive product being used. It has been found that although radio-I is separable mainly as the free element, Cl and Br are largely extracted as anions. The addition of a little aniline to the halide before irradiation has given a larger yield of extractable radio-Br. A method based on this reaction for preparing highly active specimens of radio-Br has been developed, and a concentration factor of 30,000 has been obtained. AUTHORS.

3981. Scattering of α-Particles in He. S. Devons. *Roy. Soc., Proc.* 172*A*. *pp.* 559–567, *Sept.* 4, 1939.—The scattering of α-particles in He has been investigated for scattering angles of 27° and 38·5°, and for energies up to 8·5 eMV. It is found that the results are consistent with the existence of a broad level of Be^8 with spin two quantum units, and with an energy of about 3·3 eMV in excess of the ground state, which is assumed to possess a mass equal to that of two α-particles. The results for α-particle energies greater than 7·0 eMV are not very accurate owing to the low intensity of the sources of thorium active deposit available. AUTHOR.

***3982. Mechanical Model Illustrating Principle of Cyclotron. F. A. B. Ward.** *Phys. Soc., Proc.* 51. *pp.* 810–816, *Sept.*, 1939.—The model illustrates by a mechanical analogy the behaviour of the ions accelerated within a cyclotron. Two horizontal semi-circular brass plates

oscillating in opposite phase in a vertical direction represent the dees of the cyclotron ; the plates are connected by a hinged ramp, and a steel ball representing an ion rolls round a series of semicircular grooves cut on the upper surfaces of the plates and receives repeated accelerations by rolling down the ramp, its path being the same as that described by an ion in the cyclotron under the combined influence of the electric and magnetic fields. AUTHOR.

3983. Residual Ionisation of Gas under Action of Radioactive Substances. F. Perrier. *Comptes Rendus*, 208. *pp.* 2064–2065, *June* 26, 1939.—The residual ionisation produced in a gas by a radiaoctive salt (1-10 mg. Ra) persists for only a few minutes. The coefficient of recombination decreases with time from 6×10^{-6} during the first few seconds to 8×10^{-7} at the end of 10 mins. There is not, as in the case of ionisation by X-rays [see Abstract 3346 (1939)] any appreciable formation of large ions, which indicates that the nature of the ionising radiation plays an essential part in the formation of large ions. H. J. H. S.

See also Abstracts 3841, 4010, 4125, 4180.

RADIATION.

ABSORPTION.

See Abstract 4012.

COLORIMETRY.

***3984. Modern Colour Technique. P. Hatschek.** *Phot. Indust.* 37. *pp.* 898–900, *Aug.* 9, 1939.—The modern use of double monochromators for investigation of the sensitivity of emulsions and photo-cells or spectral distribution of light sources is explained and the difference between " simple " and " double " dispersion illustrated. An instrument is described in which mirrors are used in place of lenses, a 30°-prism and plane mirror forming the dispersing element. Both prisms are moved by one wave-length drum and the second can be used on either of two tables so geared that one gives " simple " and the other " double " dispersion. F. S.

3985. Method of Designating Colours. D. B. Judd and K. L. Kelly. *Bureau of Standards, J. of Research*, 23. *pp.* 355–385, *Sept.*, 1939.—In 1931 the first chairman of the Inter-Society Colour Council, E. N. Gathercoal, proposed on behalf of the United States Pharmacopoeial Committee the problem of devising a system of colour designations for drugs and chemicals. He said, " A means of designating colours in the United States Pharmacopoeia, in the National Formulary, and in general pharmaceutical literature is desired; such designation to be sufficiently standardised as to be acceptable and usable by science, sufficiently broad to be appreciated and used by science, art, and industry, and sufficiently commonplace to be understood, at least in a general way, by the whole public." With the assistance of the American Pharmaceutical Association, and following plans outlined in 1933 by the Inter-Society Colour Council, there has been worked out a solution for this problem, which substantially fulfils the requirements. AUTHORS.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

3986. Negative Faraday Effect Independent of Temperature. G. Gassmann. *Ann. d. Physik*, 35. 7. *pp.* 638–656, *Aug.*, 1939.—The effect of temperature and wave-length on the magnetic rotation of a number of solids and liquids, especially those with paramagnetic susceptibility independent of temperature, has been investigated. The substances used include uranium trioxide, titanic chloride, chromium trioxide, barium permanganate, aluminium oxide, tungsten trioxide, cuprous chloride, hexamminocobaltic perchlorate, sodium nitroprusside, and potassium ferrocyanide. Those complexes of elements of the transition series in a high valency state which may be regarded as having a structure approximating to that of the inert gases, show a strong negative rotation which is approximately independent of temperature. The results are discussed qualitatively on the basis of Serber's theory. A. J. M.

See also Abstract 4009.

EMISSION.

3987. Fluctuations in Electromagnetic Radiation. M. Born and K. Fuchs. *Roy. Soc., Proc.* 172*A*. *pp.* 465–466, *Sept.* 4, 1939.—A correction to the original [see Abstract 1613 (1939)].

3988. Tables of Planck's Formula for Radiation. Part III. Tables of Luminosity Factors. Z. Yamauti and M. Okamatu. *Electrot Laborat. Tokyo, Japan, Researches, No.* 420. [69 *pp.*], 1939. *English Abstract.*—Tables are constructed to facilitate the computation of the relative luminosity of a Planckian radiator. Values of $\log_{10}(T/C_2)$ and the corresponding values of $\log_{10}F(\lambda T/C_2)$ are tabulated at intervals of $0{\cdot}01\,\mu$ for wave-lengths from $0{\cdot}40\,\mu$ to $0{\cdot}76\,\mu$ and for values of $\log_{10}(T/C_2)$ ranging from $\bar{1}{\cdot}140$ to $\bar{1}{\cdot}350$ at intervals of 0·001 (1977° to 3206° K. with $C_2 = 14320\,\mu$), the values of $\log_{10}F(\lambda T/C_2)$ being given to 5 significant figures. Two additional tables enable the spectral luminosity factor to be easily obtained for any wave-length. [For Part II see Abstract 3068 (1937).] R. W. P.

3989. Total Emission. Parts I and II. A. Carrelli. *Accad. Lincei, Atti*, 29. *pp.* 241–247, *March* 4, *and pp.* 381–388, *April* 15, 1939.—In the first part a theoretical derivation of the total emission of substances possessing one maximum of absorption is given as function of the temperature. In the second part the results are discussed of experimental investigations of the total emission of Pt, Ag, NaCl, LiCl, KCl, $CaSO_4$, Na_2SO_4 and the oxides of Zn, Ag, Ca and Co. All were examined in the temperature interval of about 600°-1000° K. The results are shown in graphs. It is found that the emissivity of Ag follows Foote's rule, *i.e.*, it depends on the free electrons only, while Pt shows deviations from this rule. In the case of the three alkali chlorides the emission as function of the temperature can be represented by the formula $E = \sigma T^{4.47}$. An analogous behaviour is shown by the sulphates while the oxides show deviations of their total emission from the exponential law. [See following Abstract.] L. K.

3990. Total Heat Emission of Ni. F. Cennamo. *N. Cimento*, 16. *pp.* 147–154, *March*, 1939.—The total radiation emitted by a strip of Ni, about 0·07 mm. thick has been measured with a thermopile and galvanometer [see preceding Abstract]. The filament was electrically heated *in vacuo*. It was found that in the temperature interval investigated

(250°-750° C.) the emitted radiation as function of the temperature can be represented by $E = \sigma T^n$, where $n = 5 \cdot 15$ for temperatures below the Curie-point, and $n = 4 \cdot 45$ for temperatures above the Curie-point. It is shown that the variation of the electric resistance of Ni with the temperature is not sufficiently great to account for the variation of the total emitted radiation. L. K.

3991. Limits of Electrodynamics and the New Experimental Results on Cosmic Radiation. G. Gentile. *N. Cimento*, 16. *pp.* 113–135, *March*, 1939.—The author shows, following the argumentation of Bohr and Rosenfeld, that the actions of electric particles are still represented by Maxwell's equations. After a discussion of the principal experimental results of the investigation of cosmic radiation the process of loss of energy by the transition of an electron into a photon is studied by the semi-classical methods of Weizsäcker. The theoretical consequences of the experimental confirmation of the validity of the electrodynamic laws for electrons of the highest energies are discussed. The author concludes that the organism of electrodynamics must be considered as an "observable" in Dirac's sense. The necessary extension of Heisenberg's uncertainty principle will add the number of electric charges of a certain sign and mass to the hitherto considered position and velocity of a particle. L. K.

3992. Atomic and Cosmic Rays in Supernovae. F. Zwicky. *Nat. Acad. Sci., Proc.* 25. *pp.* 338–344, *July*, 1939.—The suggestion was made some years ago by Baade and the author that (1) certain novae displaying characteristic properties but in superlative degree might be designated "supernovae", and (2) that these supernovae are an origin of cosmic rays. The identification and study of nine active supernovae with the Schmidt telescope on Mount Palomar is the foundation for this general discussion of processes which might produce cosmic rays as well as atomic rays of high energy. The observed progressive red shift in four recent bright supernovae is discussed and it is concluded that interstellar space is continually supplied with atomic rays made up of high speed atoms and ions with kinetic energy proportional to their atomic weights. Further topics discussed are the probable generation of cosmic rays by the breakdown of electric fields built up through violent fission, and by the generation of large differences in electric potential due to selective action of light pressure on various particles. It is concluded that supernovae may be a powerful source of cosmic rays, and that the asymmetry causing the east-west effect may be satisfactorily explained. E. M. W.

3993. Annual Fluctuation in Intensity of Cosmic Rays. G. R. Miczaika. *Zeits. f. Physik*, 113. 3–4. *pp.* 161–165, 1939.—Measurements of cosmic-ray intensity at Potsdam from Feb. 1933 to March 1934 show that a maximum occurs in Jan.-Feb. and a minimum in August, the total intensity variation being 2·9 % of the mean value. Comparison with other measurements shows that the amplitude of the monthly mean intensity increases with latitude from equator to poles; this variation is interpreted as a temperature effect. From the temperature coefficient the mean free path of the mesotron is calculated as 25 km. J. E. K.

3994. Trajectories of Cosmic-Ray Particles in Earth's Field. Tchang Yong-Li. *Ann. Soc. Sci. de Bruxelles*, 59. *pp.* 285–345, *July* 12, 1939.—In the first paper the author develops the analysis already initiated by Lemaître of the penumbral cone for latitudes infinitely near the equator and for energies infinitely near to $\sqrt{2}$–1 störmer. The second constitutes a

revision and extension of earlier work (by Bouckaert) on orbits asymptotic to periodic orbits of rays near the equator and near the Störmer limit. D. H. F.

3995. Variations in Cosmic-Ray Showers. W. Kolhörster. *Phys. Zeits.* 40. *pp.* 488–490, *July* 15, 1939.—Recording of showers was carried out over a period of about 6 months using an assembly of three widely spaced counters under a wood roof of water-equivalent thickness 7·4 cm. The observations were divided into three-hourly periods and the shower-frequency averaged for each period over the whole duration. A regular variation during the 24 hours then appears: this is shown to have a positive correlation with surface temperature, and consequently, there being no correlation with pressure, a negative correlation with air density. Shower-rates averaged over the whole day showed negative correlations with air-pressure and temperature and a positive correlation with density: similar daily averages of vertical intensity showed correlations of the same sign. The author relates the temperature correlation of the vertical intensity with the increase, with temperature, in the height at which mesotrons originate, and the shower correlation with the decay products of the mesotrons in the lower levels of the atmosphere. D. H. F.

3996. Absorption of Penetrating Cosmic-Ray Particles in Gold. J. G. Wilson. *Roy. Soc., Proc.* 172*A*. *pp.* 517–529, *Sept.* 4, 1939.—Absorption measurements of the penetrating component of cosmic radiation have been made by cloud-chamber observations of the curvature change of tracks in a field of 10,000 G, using a gold absorber 2 cm. thick. At low energies ($E_e < 7 \times 10^8$ eV) the measurements indicate an absorption due entirely to ionisation; from a track of very low energy ($E_e < 2 \times 10^8$ eV) the increase of this absorption leads to an estimate of the mass of the mesotrons of $\mu = (170 \pm 20)m_0$. There is no indication of cross-sections for interaction of mesotrons with nuclear particles of comparable magnitude to that for absorption by ionisation. At higher energies ($E_e > 7 \times 10^8$ eV) a few particles were observed which appeared to undergo greater absorption, and these are shown to be in agreement with our previous measurements. Experiments due to Ehrenfest make it unlikely that these particles belong to the predominant group of mesotrons, and it is probable that they are protons. Since the article emerging from the gold plate is, in some cases, definitely not a proton, this hypothesis suggests a strong absorption of protons with the production of mesotrons in 2 cm. gold. A similar process has been suggested by Johnson for the production of mesotrons in the upper atmosphere. AUTHOR.

3997. Shower Production by Penetrating Cosmic Rays. A. C. B. Lovell. *Roy. Soc., Proc.* 172*A*. *pp.* 568–582, *Sept.* 4, 1939.—A counter controlled cloud chamber has been used to investigate cosmic-ray showers under thick layers of lead. 5000 photographs, containing 463 electronic showers of not less than 5 particles, have been taken in a magnetic field of 750 G. An analysis of the evidence and probabilities for various possible processes of shower production is carried out, and it is shown that the showers observed can be accounted for as cascade showers, produced by an electron which has been knocked-on in a direct collision with a mesotron. It is unnecessary to assume the occurrence of other processes of appreciable cross-section. Due to the influence of the incident energy spectrum of mesotrons, the majority of large showers are produced as fluctuations, and in general, the lowest mesotron energy which is able to produce a shower of N particles is only slightly lower than the most probable energy for the

roduction of such a shower. A search has been made to find showers, or ngle secondary particles, produced by neutral particles in cosmic radiation ith negative results. AUTHOR.

See also Abstract 3895.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

3998. Measurements of Fluorescence and Absorption of Benzene Derivatives, especially in Condensed Systems. H. Ley and H. Specker. *Zeits. f. wiss. Phot.* 38. *pp.* 96–110, *April–June*, 1939.—ontinuation of earlier work [see Abstract 2858 (1939)]. The measurements were carried out on solutions of the substances in suitable solvents. Hydrocarbons containing several benzene nuclei show an emission approximately identical with that of C_6H_6 itself, provided the double bond is not conjugated with those of the benzene nuclei (*e.g.* $(C_6H_5)_2CH_2$; $C_6H_5\ CH_2\ CH_2\ C_6H_5$). As soon as conjugation is present, a new fluorescence appeared displaced towards the red, *e.g.* stilbene. Transformation from an open into a condensed system with two benzene nuclei leads to displacement of emission and absorption towards the red. The condensed system containing three benzene nuclei (anthracene) shows very strong and characteristic band fluorescence. Dihydroanthracene, fluorene and diphenyl methane possess only *one* emission and absorption region; the long-wave region often found, is due to adventitious anthracene. Anthramine gives characteristic absorption and fluorescence, but on salt formation the spectrum reverts to that of anthracene. Dihydro- and octahydroanthacene show fluorescence almost identical with that of C_6H_6 (2700–3200 Å), hence proof of their structure. The relation between refraction and absorption (and fluorescence) is discussed with particular reference to Fajans' theory of ion deformation and the Drude-Lorentz electron theory of refraction. S. J. G.

3999. Fluorescence and Photochemical Kinetics of Polyatomic Molecules in the Gas Phase. W. A. Noyes, Jr. and F. C. Henriques, Jr. *J. Chem. Phys.* 7. *pp.* 767–774; *Disc.*, 774, *Sept.*, 1939.—Various mechanisms for the excitation and quenching of fluorescence are discussed. It is pointed out that the classical Stern-Volmer mechanism may apparently be obeyed in cases where the process is not that of simple absorption followed by fluorescence and collisional deactivation. For polyatomic molecules a spectroscopic examination will not always disclose definitely the nature of the emitting radical or molecule. A study of the effects of several variables on the intensity of the fluorescence will frequently give much information about the lifetimes of the emitting molecules and the course of the photochemical reactions taking place. Quantitative studies of the fluorescence in the gas phase have been made for very few polyatomic molecules. NO_2 and acetone are cited as examples. AUTHORS.

4000. Elementary Processes in the Sensitised Fluorescence of OH Molecules. E. R. Lyman. *Phys. Rev.* 56. *pp.* 466–470, *Sept.* 1, 1939.—The processes involved in the sensitised fluorescence excitation of the OH molecules have been investigated by photometric measurements of the intensities of lines of the (0,0), (1,0) and (1,1) OH bands. Collisions between metastable $^3P_0$ Hg atoms and water molecules produce unexcited OH molecules which are then excited by further collisions with $^3P_0$ Hg atoms to levels whose energies are equal to or less than the energy of the $^3P_0$ Hg atoms. Abnormal rotational energy is produced in the excitation

of the OH molecules. Collisions between N_2 and OH molecules transfer vibrational energy of the OH molecules to rotational energy and also reduce the rotational energy of the OH molecules somewhat toward thermal values. Collisions between helium and OH molecules are very much less effective in transferring energy than N_2 collisions. AUTHOR.

4001. Fluorescence and Reversible Energy Transfer in Reversibly Polymerised Dyestuffs. G. Scheibe, A. Schöntag and F. Katheder. *Naturwiss.* 27. *pp.* 499–501, *July* 21, 1939.—Gives reasons for supposing that in the new kind of reversibly polymerised pseudo-isocyanine, light energy absorbed at one molecule may be transferred over more than 10000 molecules in less than 10^{-8} sec. The reasons are based on the nature of the fluorescence and absorption bands and on the extreme sensitiveness of the fluorescence to quenching molecules. J. E.

4002. Fluorescent Power of Uranin Solutions as a Function of Their H-Ion Concentration. A. Boutaric and M. Roy. *Comptes Rendus*, 209. *pp.* 162–164, *July* 17, 1939.—Using different solutions as sources of H-ions it is found that in all cases fluorescent power against H-ion concentration follows the same curve, as long as the anions do not inhibit the fluorescence. Where the fluorescent power for a given H-ion concentration is less than that in a non-inhibiting solution the relative decrease is taken as a measure of the inhibiting power of the anions present. J. E.

4003. Fluorescent Spectra of Artificial Fluorites Activated with Rare-Earths and Their Interpretation. N. Chatterjee. *Zeits. f. Physik*, 113. 1–2. *pp.* 96–114, 1939.—Details are given of the preparation of fluorescent fluorites activated with Sm, Eu, Dy and Er and of YF_3-Eu. The analysis of the fluorescent spectra of these substances under excitation by light and by kathode rays is given and also the absorption spectra of CaF_2 and CaF_2-Er. The interpretation of the spectra can in most cases be given in terms of transitions in the triply-charged ions. In the case of the Er^{+++} spectra some of the lines both in emission and absorption are accounted for by transitions within the ground term multiplet. J. E.

4004. Quenching and Depolarisation of Hg Fluorescence by H_2 and D_2. F. Suppe. *Zeit. f. Physik*, 113. 3–4. *pp.* 141–149, 1939.—It is found that the two isotopes in spite of their different masses and different velocities act in the same way and to the same extent in quenching and depolarising the Hg resonance fluorescence. But if depolarisation has already been produced by N_2 the further addition of either H_2 or D_2 gives an increase in polarisation. J. E.

4005. Polarisation of Fluorescence of Molecules in the Vapour State and in Solution. F. Suppe. *Zeits. f. Physik*, 113. 5–6. *pp.* 281–286, 1939.—The degree of polarisation of anthracene in solution at different concentrations and as vapour at different pressures has been determined. The polarisation in the two states is nearly the same for the same number of molecules per unit volume if this number is greater than 10^{16} per cm^3. J. E.

4006. Sensitisation of Phosphorescent ZnS by Red Rays. J. Saddy. *Comptes Rendus*, 209. *pp.* 93–95, *July* 10, 1939.—The author has noted that additions of traces of Fe produces an enhancement of the quenching effect of red rays. A product containing Cu and Fe fluoresced strongly under Wood ultra-violet but not at all under an incandescent lamp rich in red. The decay of luminescence was studied in two products, one containing Fe and one not; each with and without red illumination

during decay. All the curves follow the relation $I = A(t + a)^{-\alpha}$ α being 0·97 for the Cu-activated, without Fe or red illumination, and just over 2 for the other three cases, the presence of Fe slightly increasing the value of α. J. E.

4007. Luminescence of Wetted Salts. J. Ewles and W. E. Martin. *Leeds Philosoph. & Lit. Soc., Proc.* 3. *pp.* 557–558, *May*, 1939.—A continuation of previous work by Ewles [*Nature*, 125. *pp.* 706–707, *May* 10, 1930]. New experimental results indicate that the luminescence of wetted salts is due to water in some kind of very intimate association with the crystals, either included in the crystal grains or adsorbed on internal cracks. J. E.

4008. Luminescence of Water under the Action of Supersonic Waves. P. Paounoff. *Comptes Rendus*, 209. *pp.* 33–36, *July* 3, 1939.—A continuation of previous work [see Abstract 675 (1935)]. The luminescence only appears when the water contains oxygen or air. The spectrum consists of a broad band from 445 to 558 $\mu\mu$. A direct photograph of the glowing water shows that the luminescence is most intense at the nodes. It is considered that the luminescence is due to decomposition of ozone by the supersonic waves. J. E.

4009. Luminescence in Electric Fields and Electronic Phenomena in Semiconductors. G. Destriau. *Comptes Rendus*, 209. *pp.* 36–37, *July* 3, 1939.—The author has shown that the relation between intensity of luminescence and electric field is $E = A.H.^n e^{-B/H}$, where the average value of n from a large number of experiments is 2. This is the same relation as for the growth of conductivity and of cold emission of electrons. It has also been found that the growth of electrophotoluminescence with temperature follows the same law as the growth of conductivity with temperature, *viz.*, $E = A.T^n.e^{-B/T}$. J. E.

4010. Luminescence of Mercury Vapour along an α-Ray Pencil, and Transfer of Nitrogen Excitation to Mercury. A. Luyckx. *Roy. Soc., Proc.* 172*A*. *pp.* 492–501, *Sept.* 4, 1939.—It is shown that Hg vapour luminescence phenomena, similar to the optically excited fluorescence phenomena, can be excited by α-rays in presence of N_2. The green luminescence renders visible an α-ray pencil by light emission ; this new method is quite different from the well-known expansion method of Wilson. However in this case no individual track was seen. The emission spectrum of this luminescence consists of a visible Hg triplet (5461, 4358, 4046), a continuum having a maximum near 4850 Å and the resonance line 2537 Å. Persistent phenomena were observed. The spectra and persistent phenomena are similar to the fluorescent phenomena. No luminescence can be seen in the absence of N_2. In a primary process the α-rays excite N_2 molecules which transfer their energy to Hg by collisions of the second kind. The green luminescence is extinguished by small quantities of air, while H_2 has no quenching effect. This survivance of the glow to the addition of large quantities of H_2 led to the assumption that this luminescence is a sort of " wing effect " due to the transfer to diatomic Hg_2 molecules of the energy of the N_2 molecules excited by α-rays. AUTHOR.

See also Abstract 4178.

INTERFERENCE, DIFFRACTION AND SCATTERING.

4011. Wide-Angle Interferences and Nature of Elementary Light Sources. P. Selényi. *Phys. Rev.* 56. *pp.* 477–479, *Sept.* 1, 1939.—It was proved, in connection with the purely theoretical papers by

Halpern and Doermann [see Abstract 1626 (1939)] that a wide-angle optical interference phenomenon can be realised only if the light source is two-dimensional with its third dimension of less than 1/10000 mm. Observations of the author made in 1911 and 1938 with a simple optical arrangement which fulfils this condition have proved that fluorescence light possesses all the properties of the simple dipole radiation. AUTHOR.

4012. U.V. Spectral Distribution of Light Diffused by Photographic Image. C. Jausseran. *Comptes Rendus*, 209. *pp.* 37–39, *July* 3, 1939.—For acute angles of diffusion the maximum lies in the same region as for the band of transmission of the Ag, but this maximum varies with the angle, increasing from 3160 to 3220 Å for angles from 0° to 40°. For obtuse angles this maximum does not occur; the distribution being fairly uniform in the visible and then decreasing rapidly to about 3200 Å after which it remains constant again. Curves relating flux diffused with flux transmitted all show a minimum at about 3160 Å. Their form is very similar to the reflection curves of Ag and it is considered that the diffused light is that transmitted and then scattered from Ag grains. This leads to the important conclusion that the light diffused from a solid does not necessarily give the absorption curve of the body. J. E.

See also Abstract 4113.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

4013. Changes in pH of Irradiated Egg Albumin Solutions. F. W. Bernhart. *Am. Chem. Soc., J.* 61. *pp.* 1953–1954, *Aug.*, 1939.—The change in pH caused by u.v. irradiation of egg albumin solutions was studied with the glass electrode. The pH of egg albumin solutions irradiated in contact with air decreases when the pH is above the isoelectric point and rises slightly when the initial pH is below the isoelectric point. The pH of egg albumin solutions which are alkaline in respect to the isoelectric point increases during irradiation under nitrogen. AUTHOR.

4014. Photosynthesis of Carbohydrates from Hydrated CO_2. E. C. C. Baly. *Roy. Soc., Proc.* 172*A*. *pp.* 445–465, *Sept.* 4, 1939.—When a surface of NiO which contains ThO_2 in the molecular ratio of 1 ThO_2 : 24 NiO, preferably adsorbed on kieselguhr, is irradiated in the presence of hydrated CO_2 an organic compound is photo-synthesised. The first product of photosynthesis, which gives the Molisch reaction after hydrolysis, is unstable and changes slowly at room-temperature and rapidly at 60° to a stable compound. This stable compound, which is colourless, can be hydrolysed by taka-diastase to a reducing sugar and is probably, therefore, a type of starch. The first product of photosynthesis is the parent of the starch, the existence of which has not hitherto been recognised. AUTHOR.

4015. Effect of Temperature on Predissociation of Photoactivated Acetaldehyde Molecules. G. K. Rollefson and D. C. Grahame. *J. Chem. Phys.* 7. *pp.* 775–779; *Disc.*, 779–781, *Sept.*, 1939.—The relative efficiencies of production of free radicals in acetaldehyde by the absorption of light of the wave-lengths 3132 and 2652 Å have been studied by observing the quantum yields of the photochemical reaction at high temperatures. It has been found that at room-temperature more radicals are produced by the absorption of 2652 Å than by 3132 Å. As the temperature is raised, the yield of radicals at the longer wave-length increases relative to that at 2652 until at 100° C. the two are equal. At higher temperatures the longer wave-length has the greater efficiency for the production of

radicals. This change with temperature is accounted for by assuming that at 3132 Å the dissociation is aided by thermally excited vibrational energy. In accordance with this assumption it is found that as the temperature is raised the fluorescence, which is easily visible at room-temperature, fades in a manner which is roughly parallel to the increase in dissociation. There is no evidence for such a thermally induced predissociation with 2652 Å The lower efficiency of production of free radicals at 2652 Å is believed to be due to a difference in the electronic states reached by acetaldehyde excited by the two-wave lengths. AUTHORS.

4016. Cadmium Photosensitised Reactions of Ethane. E. W. R. Steacie and R. Potvin. *J. Chem. Phys.* 7 *pp.* 782–789 ; *Disc.*, 789, *Sept.*, 1939.—An investigation of the Cd photosensitised reactions of ethane has been made. It is concluded that the primary process is a C—H bond split, probably by the reaction Cd $(^3P_1) + C_2H_6 = CdH + C_2H_5$. The products of the reaction are hydrogen, methane, propane, butane, and higher hydro-carbons. The methane probably largely results from methyl radicals produced by $H + C_2H_5 = 2CH_3$, and the higher hydrocarbons from recombination reactions of radicals. Two experiments have also been made on the decomposition of propane and butane. AUTHORS.

4017. Effect of Adaptation and Contrast on Apparent Brightness. F. H. G. Pitt. *Kodak Research Lab., Comm. No. H*688. *Phys. Soc., Proc.* 51. *pp.* 817–830, *Sept.*, 1939.—Measurements have been made of the variation of the brightness-sensitivity of the eye over a range of adaptation brightnesses extending from 0·001 to 400 equivalent foot-candles. The method adopted involves the use of binocular matching, the left eye, at a constant state of adaptation, being used as a reference standard, and the right eye, adapted to various brightnesses, viewing a test patch. From the experimental results, curves each of which represents physical brightnesses differing from those for subjective black by a constant number of just noticeable brightness-differences, and curves of equal apparent brightness have been constructed. It is shown that the brightness of the surround field has a very great effect on the apparent brightness of the test patch, the change caused by changing the surround brightness being almost instantaneous. The effect of this surround field, viewed with the right eye, on the comparison patch, as viewed with the left eye, both fields merging binocularly, is discussed and is shown to be negligible at least in comparison with the first-mentioned effect. The results obtained show that it may be impossible to construct sensation curves of the simple type hitherto postulated for considering the reproduction of photographic tone. AUTHOR.

4018. Rôle of Oxidation Products in the Process of Development. H. Staude. *Zeits. f. wiss. Phot.* 38. *pp.* 65–96, *April–June*, 1939.—Developers give irreproducible results if O_2 is rigorously excluded, so that oxidation products (O.P.) of the developers must play an essential rôle in development. The nature of these products has been investigated and their effect studied quantitatively for (a) a typical " deep " developer, hydroquinone + soda, and (b) the typical " surface " developers amidol and soda metol + borax, amidol + borax, both in presence and in absence of So_3^{--} and of KBr, and at different values of pH. The photographic layer—Perutz photochemical A, Ag Br emulsion, AgBr—AgI plate or Zeiss-Ikon positive film—were illuminated, cut in two and one half then developed in ordinary developer and the other in the corresponding developer specially freed from O_2 and O.P. by Na amalgam or Zn-Cu

couple. The latent time t (time required for first appearance of image) for hydroquinone was invariably less in presence of O.P. than in their absence, the most important such product being quinone. Amidol and metol give similar results though for metol, in presence of KBr but absence of SO_3^{--}, O.P. cause an increase in t. This is due to formation of $O = C_6H_4—N—N—C_6H_4 = O$ (with no developing powers) which is inhibited by SO_3^{--}. S. J. G.

4019. Callier Coefficient and its Relation to Graininess. S. D. Threadgold. *Phot. J.* 79. *pp.* 524–527; *Disc.*, 527–529, *Aug.*, 1939. —Discusses data published by other authors, in which the use of the Callier coefficient as a means of measuring graininess of photographic materials, first suggested by the present author [see Abstract 4944 (1932)], is approved by some, and not by others. The method is only suitable for use with negative materials, and the conclusion reached is that the majority of available evidence appears to indicate that the method, if properly applied, leads to satisfactory results. R. C. F.

4020. Relation between Sensitometric and Size-Frequency Characteristics of Emulsions. L. Silberstein and A. P. H. Trivelli. *Kodak Research Lab., Comm. No.* 679. *J.O.S.A.* 29. *p.* 354, *Aug.*, 1939.—A correction to the original [see Abstract 255 (1939)].

4021. Standardisation of Photographic Sensitometry Based on the Addition Law. A. van Kreveld. *J.O.S.A.* 29. *pp.* 327–336, *Aug.*, 1939.—From the absolute spectral sensitivities of 26 common emulsions various practical sensitometric magnitudes have been computed by means of the addition law. The following conclusions have been drawn: (1) The integral sensitivity of panchromatic emulsions does not exceed considerably that of orthochromatic and noncolour-sensitive emulsions. (2) For all of the emulsions, even for the panchromatic ones, the sensitivity to tungsten incandescent light is lower than to daylight. (3) The colour sensitivity of all of the emulsions is far below the desirable level. (4) The colour sensitivity does not depend significantly on the kind of illumination applied. (5) Five sensitometric numbers satisfy all practical requirements. They are: the integral sensitivity to daylight, the same to tungsten incandescent light and the relative colour sensitivity to green, yellow and red, respectively (compared with blue). AUTHOR.

4022. Electrolytic Development of Latent Image. R. S. Morse. *Kodak Research Lab., Comm. No.* 729. *Frank. Inst., J.* 228. *pp.* 169–175, *Aug.*, 1939.—It has been found that if a photographic material of the Ag halide type is exposed and subsequently bathed in an NH_3 solution containing a trace of a suitable metallic salt, a visible image may be produced by placing the emulsion in intimate contact with a clean Cu plate. This process is investigated in detail and some theoretical suggestions are made. A. H.

4023. Number of Quanta Required to Form Latent Image as Determined from Mathematical Analysis of H. and D. Curve. J. H. Webb. *Kodak Research Lab., Comm. No.* 738. *J.O.S.A.* 29. *pp.* 309–313, *Aug.*, 1939.—One method of approach which has been used to determine the number of quanta utilised by a photographic grain in acquiring a latent image is through mathematical analysis of the characteristic (H. and D.) curve of the emulsion. For the most part, the theoretical investigations of this problem have been based on the fundamental assumption that a fixed, minimum number of quanta are required for the production of a just developable latent image, this minimum number being

assumed to be the same for every grain. Analyses based on this assumption have all led to the conclusion that a small number of quanta (1 to 4) are involved in latent-image formation. A study of the method of treatment of the exposure problem outlined above is presented here in order to show to what extent the conclusion about the number of quanta used rests on experimental fact and to what extent it is dependent upon the fundamental assumptions made in the analysis. It is shown that the conclusion of a small number of quanta arrived at is directly dependent upon the basic assumption that all grains have the same inherent sensitivity, and therefore may be considered valid in just so far as this assumption is found to be in accord with experimental fact. [See following Abstract.] AUTHOR.

4024. Graphical Analysis of Photographic Exposure and New Theoretical Formulation of H. and D. Curve. J. H. Webb. *Kodak Research Lab., Comm. No.* 739. *J.O.S.A.* 29. *pp.* 314–326, *Aug.*, 1939.—A graphical analysis of the photographic exposure problem is given based on the assumption that the sensitivity variation among grains of a photographic emulsion depends upon an inherent variation in grain sensitivity among grains of the same size class as well as upon the size distribution. Using the graphical model developed, a theoretical equation of the H. and D. curve is derived. On account of the mathematical form, the equation cannot be integrated. It is necessary, therefore, to obtain the theoretical curves from this equation by graphical methods. Curves obtained by means of the equation are compared with experimental curves for three widely different types of emulsions, and the agreement is quite satisfactory. [See preceding Abstract.] AUTHOR.

See also Abstracts 3984, 3999, 4087.

PHOTOMETRY.

4025. Relative Luminosity of Radiation for Average Photometric Observer. Part II. J. S. Preston. *Phys. Soc., Proc.* 51. *pp.* 757–767, *Sept.*, 1939.—This paper describes measurements of the mean relative luminosity of radiation at five wave-lengths in the spectrum, made by 20 observers. Work described by the author in a previous paper on the relative luminosity at wave-lengths 5461 and 5780 Å of the Hg spectrum is followed up by the inclusion of the Na doublet at 5893 Å and the Cd lines at 5086 and 6439 Å. Electric discharge lamps were used as light-sources, and their visual intensity in different spectrum lines was compared with the energy radiated in these lines by the method described previously. A connection between the values for individual observers and their Y/B ratios is confirmed and utilised to reduce the results to average-observer conditions. The results are consistent with a relative-luminosity curve which fits the standard curve except between wave-lengths 5550 and 6350 Å, where the new observed values are up to 11% higher than the standard values. The results also suggest the possibility of changes in the values obtained over a period of time. Possible causes, such as dietetic influences, are discussed, as are also the effects of changes in photometric conditions. The probable error of the results is also dealt with. [For Part I see Abstract 2007 (1938).] AUTHOR.

See also Abstracts 3962, 4017 and
2207B. Design of Photoelectric Flicker Photometers. P. Moon and D. P. Severance.

POLARISATION.

See Abstract 3915.

REFLECTION, REFRACTION AND DISPERSION.

4026. Representation of Space by Narrow Packets in the Seidel Zone. S. Huber. *Zeits. f. Physik*, 113. 5–6. *pp.* 350–359, 1939.—The necessary conditions are first stated for the space representation of optical instruments (space stigmatism). By limitation to axial zones, it has been possible to make trihedral space stigmatism to depend on the solution of a quadratic equation. Trihedral space stigmatisms are possible in strongly bent circumstances. It is shown how by variations of construction all necessary data for space stigmatism may be obtained with sufficient accuracy by a graphical method. H. H. Ho.

4027. Microscopic Representation of Cylinders and Coils. N. Günther. *Zeits. f. Instrumentenk.* 59. *pp.* 315–321, *Aug.*, 1939.—The object of this paper is to derive those illumination apertures by which the geometrical data for cylinders and coils may be obtained within the limits afforded by the microscope. The treatment, which is entirely mathematical, deals with the physiological shading limits, the shade limits of geometrical optics, the most favourable stops, and the determination of flank diameters and angles of coils. From a large number of measurements with different apertures interpolation and error formulæ have been derived for the data required. H. H. Ho.

4028. Equivalent Lenses. F. Staeble. *Zeits. f. Instrumentenk.* 59. *pp.* 321–324, *Aug.*, 1939.—This mathematical paper deals with the problem of the equivalent lens. The treatment is based on the work of Kerber and Berek, which is critically examined and extended. [See also Abstract 3279 (1939).] H. H. Ho.

4029. Dioptric Investigations. H. Schulz. *Zeits. f. Instrumentenk.* 59. *pp.* 325–329, *Aug.*, 1939.—The writer discusses the design of optical systems employing variable magnification and contrary to usual practice deals with the image-forming lens and the magnifying lenses as a single system. W. S. S.

4030. Oblique Refraction through a Cylinder. H. W. Lee. *Phys. Soc., Proc.* 51. *pp.* 768–771, *Sept.* 1939.—The power and the first-order aberration of a cylindrical lens are found when the incident light is not normal to the axis of the cylinder. AUTHOR.

4031. Measurement of Birefringence in the Far Ultra-Violet. R. Servant. *Comptes Rendus*, 209. *pp.* 206–207, *July* 24, 1939.—Using the vacuum spectropolarimeter [see Abstract 4672 (1936)], previous work on the birefringence of barytes and gypsum [see Abstract 4171 (1936)] has been extended to the Schumann region. In this region the principal birefringence of barytes (n_m-n_p) has a value six times greater than its value in the visible. W. R. A.

4032. Dispersion of a Prism. M. E. Sutton and A. Harvey. *Phys. Soc., Proc.* 51. *pp.* 803–804, *Sept.*, 1939.—The paper describes a method, suitable for use and teaching, of verifying Monk's formula for the dispersion of a prism. AUTHORS.

4033. Atomic Refraction of Sulphur in Inorganic Compounds. G. Spacu and E. Popper. *Zeits. f. phys. Chem.* 184. *Abt. A.* 5. *pp.* 367–372, 1939.—The refractive indices and molecular refractions of aqueous solutions of sodium sulphate, sulphite, thiosulphate, and tetrathionate.

and potassium hydrosulphide have been determined. The atomic refraction of S in each compound was calculated, the values obtained being: S^{VI} 1·115, S^{IV} 2·188, S^{II} 9·557, S$\langle^{(S)}_{(Na)}$ 4·106, S$\langle^{(S)}_{(S)}$ 10·56. A. J. M.

See also Abstract 3956.

SPECTROSCOPY.

4034. Absorption Spectra of Quinones. L. Brüll and F. Griffi. *Gazz. Chim. Ital.* 69. 1. *pp.* 28–31, *Jan.*, 1939.—The plot of log E against λ for 4000–7000 Å is given for $N/50$ solutions in benzol, and the following absorption constants are deduced.

Substance	Absorption constants at Wave-Lengths		
	4919Å	5770Å	6591Å
Quinone	0·160	0·115	0·060
Chloroquinone ..	0·126	0·105	0·085
Chloraniline	0·105	0·141	0·114
Bromaniline ..	0·075	0·102	0·115
Thymoquinone ..	0·251	0·303	0·274

D. R. H.

4035. Physical Properties of Quinhydrone Solutions. L. Brüll and F. Griffi. *Gazz. Chim. Ital.* 69. 1. *pp.* 44–56, *Jan.*, 1939.—The authors report the absorption (as measured by a Hüfner spectrophotometer) of solutions of quinone, quinhydrone, and hydroquinone, separately and in admixture, in 50 %, 70 % and 95 % aqueous alcohol as solvent. Values are quoted for 10 wave-lengths between 4350 and 6561 Å, and so far as possible at concentrations of $N/10$, $N/20$, $N/50$, $N/100$, and at saturation. From a consideration of the values and of the plots of log E against λ the author deduces the following dissociation constants for quinhydrone at concentrations of $N/10$, $N/20$, $N/50$ and $N/100$, respectively—In 95 % alcohol 0·18, 0·12, 024,—; in 70 % alcohol 0·039, 0·030, 0·037, 0·037; in 50 % alcohol 0·0016, 0·00114, 0·0016, 0·0015. It appears that the degree of dissociation increases with dilution and with *decreasing* water content of the alcohol. D. R. H.

4036. Third Spark Spectrum of Krypton Kr IV. A. B. Rao and S. G. Krishnamurty. *Phys. Soc., Proc.* 51. *pp.* 772–777, *Sept.*, 1939.—The spectrum of a highly condensed discharge through fine capillary tubes containing Kr is studied with the help of a large quartz Littrow spectrograph. An examination of the data led to the identification of the multiplets $5s\ ^4P$–$5p\ ^4D$, $5s\ ^4P$–$5p\ ^4P$, etc., occurring in the near u.v. The important intervals $5s\ ^4P_{\frac{1}{2}}$–$5s\ ^4P_{1\frac{1}{2}}$ and $5s\ ^4P_{1\frac{1}{2}}$ –$5s\ ^4P_{2\frac{1}{2}}$ are 3100 and 3223 cm.$^{-1}$ respectively. A term scheme is set up, involving the classification of about 60 lines. AUTHORS.

4037. Origin of Colour of Paramagnetic Ions in Solution. Part II. D. M. Bose and P. C. Mukherji. *Indian Journ. Phys.* 13. *pp.* 219–230, *June*, 1939.—In a previous paper [see Abstract 287 (1939)] the number and positions of the principal absorption bands of paramagnetic ions in solution were found to be capable of being accounted for by means of an empirical formula proposed by the authors. Most of the bands were found to consist of doublets, whose frequency difference was of the order of 2000 cm.$^{-1}$ for the *D*-ions and of the order of 750 cm.$^{-1}$ for the *F*-ions.

In the present paper the doublet structure is accounted for as due to the presence of a superposed field of trigonal symmetry round the paramagnetic ions which is supposed to be due to the directed positions of the anions with respect to the kations in solution. The splitting is found to be of the same order of magnitude as that calculated by van Vleck for the *D*- and *F*-ions due to a trigonal field present in the alums containing these ions.

AUTHORS.

4038. Second Spectrum of Chlorine and its Structure. C. C. Kiess and T. L. deBruin. *Bureau of Standards, J. of Research.* 23. *pp.* 443–470, *Sept.*, 1939.—New wave-lengths of Cl II, extending from 9483 Å, in the infra-red, to 2100 Å in the u.v., have been derived at the National Bureau of Standards from observations employing Geissler-tube and electrodeless discharges as light sources. These, together with unpublished observations of the Schumann region made by others, have been used to extend the analysis of the term system of Cl II. New terms have been added to the partially known quintet and triplet systems, and the singlet system has been established. All three systems are linked together with intersystem combinations. Series of ^5S and ^3S terms, with ^4S of Cl III as their limit and of ^3D terms, with ^2D of Cl III as their limit, are in excellent agreement in fixing the value of the deepest term at 192,000 cm.$^{-1}$, whence an ionisation potential of 23·70 V is derived for Cl^+. AUTHORS.

4039. Relative Intensities of Singlet-Singlet and Singlet-Triplet Transitions. G. W. King and J. H. van Vleck. *Phys. Rev.* 56. *pp.* 464–465, *Sept.* 1, 1939.—The ratio of the intensities of singlet-triplet to singlet-singlet transitions can be calculated by means of Houston's formulae in two ways: (a) from the deviations from the interval rule, and (b) from the distance of the singlet level from the centre of gravity of the triplet levels. The discrepancy of the two calculations indicates that the integral of the radial functions between the singlet and triplet differs from that for the triplet with triplet, say be a factor λ. The new parameter λ is evaluated ($\sim 0{\cdot}75$) from the positions of the four levels, and gives intensity ratios in good agreement with the observed. AUTHORS.

4040. Nuclear Spin and Magnetic Moment of $_{13}Al^{27}$. S. Millman and P. Kusch. *Phys. Rev.* 56. *pp.* 303–304, *Aug.* 15, 1939.—The molecular beam magnetic resonance method has been applied to a determination of the gyromagnetic properties of the Al^{27} nucleus. The observed gyromagnetic ratio is $1{\cdot}451 \pm 0{\cdot}004$ in units of $e/2Mc$. A comparison of this ratio with that obtained from the hyperfine splitting of several Al lines for various assumed values of the spin of Al^{27} fixes the spin of this nucleus as 5/2. The value of the magnetic moment is then found to be $3{\cdot}628 \pm 0{\cdot}010$ nuclear magnetons. The sign of the moment is experimentally determined to be positive. AUTHORS.

4041. Mechanical and Magnetic Moments and the Quadrupole Moment of the Rare ^{176}Cp Nucleus. H. Schüler and H. Gollnow. *Zeits. f. Physik*, 113. 1–2. *pp.* 1–9, 1939.—From hyperfine structure analysis and comparison with that of ^{175}Cp the mechanical, magnetic and quadrupole moments of the rare isotope ^{176}Cp are determined; the values found are $i \gtrless 7$; $\mu = +3{\cdot}8 \pm 0{\cdot}7$ nuclear magnetons and $q = +6$ to 8×10^{-24} cm^2. respectively. Atomic nuclei of the same class (odd number of protons mentrons) have mechanical moments $i = 1$ and magnetic moments less than 1 nuclear magneton. The value $i \gtrless 7$ far exceeds the previous

largest nuclear mechanical moment reported, i = 9/2. The bearing of the high mechanical moment on the radioactive delay of ^{176}Cp is discussed.

J. E. K.

4042. Far Infra-Red Absorption Spectra of Nitrites. P. Barchewitz and M. Parodi. *Comptes Rendus*, 209. *pp.* 30–31, *July* 3, 1939.—A number of bands have been observed in the infra-red absorption spectra of the nitriles C_6H_5CN, CCl_2HCN, C_2H_5CN, C_3H_7CN, CH_3CN. All possess a band between 375 and 390 cm^{-1}. which is attributed to the bond C ≡ N and another which lies between 244 and 264 cm^{-1}. The bands of lower frequency than 350 cm^{-1}. observed with acetonitrile are attributed to rotation of the CH_3 group around the axis of symmetry. A set of bands obtained with CH_3I fits in with this hypothesis. J. E.

4043. Infra-Red Study of Hydrazoic Acid. M. M. Davies. *Faraday Soc., Trans.* 35. *pp.* 1184–1192, *Sept.*, 1939.—An infra-red study of HN_3, from 2 μ to 21 μ has led to the identification of five of its fundamental frequencies: 3336 cm^{-1}., 2139·6 cm^{-1}., 1271 cm^{-1}., 1150 cm^{-1}., and 540 cm^{-1}. The bands at 3336 cm^{-1}. and 2140 cm^{-1}. have been examined under high dispersion. The results indicate a structure in which the N_3 group is linear and an approximate evaluation of their force constants shows that both N–N bonds are near normal double bonds.

Author.

4044. Vibration Spectra and Molecular Structure. Part VIII. Absorption Spectra of Light and Heavy Phenol and Aniline Vapours. V. Williams, R. Hofstadter and R. C. Herman. *J. Chem. Phys.* 7. *pp.* 802–805, *Sept.*, 1939.—The near infra-red spectra of light and heavy phenol and aniline vapours have been obtained with a rock-salt spectrometer. Comparisons have been made between the spectra of the light compounds as found in various phases, and an interpretation of certain changes occurring in the spectrum of phenol is suggested. The spectra of the heavy compounds have suggested certain assignments, such as the δ (OD) vibration at 913 cm^{-1}. in heavy phenol and the δ (OH) vibration at 1177 cm^{-1}. in light phenol. [For Part VII see Abstract 3303 (1939) with **Erratum** and **Addendum**, *ibid p.* 630, *Aug.*, 1939.] Authors.

4045. Band Spectrum of SbO. A. K. Sen Gupta. *Indian Journ. Phys.* 13. *pp.* 145–157, *June*, 1939.—The paper reports the vibrational structure analysis of the emission band spectrum of the diatomic molecule, SbO, in the region λ3200-λ6800. The bands have been assigned to two systems designated as the more refrangible and the less refrangible systems of the molecule and are due respectively to $^2\Sigma \rightarrow {}^2\Pi$ and $^2\Pi \rightarrow \Pi^2$ transitions. They have a common lower state which shows a separation of 2272 cm^{-1}., between its Π-components. From analogy with the other members of the group V(*b*) oxides, this common lower state seems in all probability to be the ground state of the molecule in question. Author.

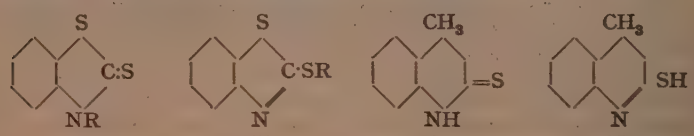
4046. Absorption and Emission Spectra of Rare-Earth Crystals. P. C. Mukherji. *Indian Journ. Phys.* 13. *pp.* 185–197, *June*, 1939.—In this paper the results of investigation of the emission and absorption spectra of the rare-earth ions like La^{+++}, Ce^{+++}, etc., in crystals are given. An attempt has been made to correlate their absorption and emission spectra with special reference to Ce^{+++} ions. It has been observed that the La^{+++} ions in crystals do not fluoresce. The emission spectra due to Ce^{+++} ions in the chloride and the sulphate crystals consist of two discrete bands. The positions of the bands are slightly different in the two salts but they occupy almost the same positions whether the salts investigated are

hydrated or dehydrated. The spectra due to CeF_3 consist of three such emission bands; further on excitation with high frequency a weak luminescence appears on the long wave-side of the bands. The strong and discrete emission bands have been supposed to be due to the true fluorescence of the Ce^{+++} ions. In conformity with the explanation of the absorption spectra due to Ce^{+++} ions by Bose and the writer, the origin of these emission bands has been ascribed to the transitions $5D \rightarrow {}^4F$ in Ce^{+++} ions. The two bands in the chloride and the sulphate and the two lower frequency bands in the fluoride arise from the transitions $5^2D_{5/2} \rightarrow 4^2F_{5/2,\ 7/2}$, while the third band in CeF_3 is due to $5^2D_{3/2} \rightarrow 4^2F_{5/2}$. It has been shown that there is a correlation between the frequency of the emission bands and the corresponding absorption frequencies. The absence of the third band in the other two crystals has been discussed. The origin of the weak luminescence is not clearly understood. It has been suggested that it is due to an excitation of the F^- ion by a collision of the second kind, with the excited Ce^{+++} ions, the process resembling somewhat a case of sensitised fluorescence. AUTHOR.

4047. Equilibrium between $(PN)_n$ and PN Deduced from Band Spectra. H. Moureu, B. Rosen and G. Wetroff. *Comptes Rendus*, 209. *pp.* 207–209, *July* 24, 1939.—The spectra of the vapour phase of phosphorus paranitride $(PN)_n$ at various temperatures have been examined. As the temperature rises the spectrum becomes richer in bands and at 750° shows continuous absorption. At 800° $(PN)_n$ decomposes into its elements. The results substantiate (i) the conclusion from chemical evidence that the equilibrium $(PN)_n \rightleftharpoons n$ PN exists, and (ii) that the $^1\Sigma$ state ($\omega_e = 1337$ cm^{-1}.) is the normal state of PN. W. R. A.

4048. Absorption Spectra of cis-Azo-Compounds. A. H. Cook, D. G. Jones and J. B. Polya. *Chem. Soc., J. pp.* 1315–1320, *Aug.*, 1939.—The absorption spectra, usually in chloroform, of numerous substituted *cis*-azo-benzenes have been determined from ca. 280 to 480 mμ. All exhibit the two-banded structure of the spectra of the *trans*-isomerides which have also been determined or redetermined, the intensity of absorption rather than the trivial changes in wave-length providing the chief distinguishing feature. Absorption spectra of stereoisomeric forms of bisbenzeneazobenzene and 4 : 4′-bisbenzeneazodiphenyl are also described. AUTHORS.

4049. Absorption Spectra of Sulphur Compounds. R. A. Morton and A. L. Stubbs. *Chem. Soc., J. pp.* 1321–1324, *Aug.*, 1939.—U.v. absorption spectra distinguish between the structures (*a*) and (*b*), and when R = H the structure corresponds to (*a*) rather than (*b*). Similarly (*c*) and (*d*) are markedly different. Comparisons with the spectra of *o*-hydroxycarbanil, 1-hydroxybenzthiazole derivatives, and substituted quinolines and quinolones support the interpretation.



AUTHORS.

4050. Absorption Spectrum of AlF. G. D. Rochester. *Phys. Rev.* 56. *pp.* 305–307, *Aug.* 15, 1939.—A new band system attributed to

the molecule AlF is described. Nearly all the observed bands can be placed into one system, with the following vibrational constants, in cm^{-1}. :

State	Probable Type	v	ω_e	$x_e\omega_e$	$y_e\omega_e$
X	$^1\Sigma$	0	814·5	8·1	—
A	$^1\Pi$	43935	822·9	8·5	0·187

AUTHOR.

4051. Infra-Red Absorption Spectrum of Methylamine Vapour. A. P. Cleaves and E. K. Plyler. *J. Chem. Phys.* 7. *pp.* 563–569, *Aug.*, 1939.—The infra-red absorption of methylamine vapour has been measured from 2 to 18μ with a cell of 18 cm. length using pressures from 2 to 55 cm. A total of 19 bands has been observed, 9 of which are assigned to fundamental vibrations. The bending vibrations of the two groups give rise to several bands in the region from 6 to 8μ. This causes considerable overlapping which makes it difficult to locate band centres and to determine band types in this region. Three bands which originate from the C — H vibrations occur at wave-lengths between 3·0 and 3·6μ. A band due to the N — H parallel valence vibration has been found at 2·98μ. The most intense band in the spectrum occurs at 12·9μ, and arises from a bending vibration of the H atoms in the amino group. The parallel vibration between the methyl and amino groups gives rise to an intense band at 9·56μ. This is a parallel band having a sharp and intense zero branch. A band also due to a bending vibration in the amino group was observed at 16μ, and from the experimental curve it cannot be said whether it is parallel or perpendicular ; hence definite assignment is not made. The other bands which have been observed have been assigned to overtones and combinations. AUTHORS.

4052. Influence of Temperature and Pressure on Infra-Red Absorption Spectrum of Gaseous and Liquid HCl. W. West. *J. Chem. Phys.* 7. *pp.* 795–801, *Sept.*, 1939.—The absorption spectra, near 1·7μ, of liquid HCl from — 100° C. to the critical temperature of 52° C., and of gaseous HCl from 1 atm. to the critical pressure of 82 atm., have been measured. The spectrum of the gas retains P and R branches about an origin undisplaced from its low pressure value up to just below the critical pressure, although discreet rotational lines are not recognisable after the density of 0·1 gm./cm^3. has been reached. At all temperatures, the transition of gas to liquid is accompanied by the replacement of the P-R branches type of spectrum by a single maximum displaced to low frequencies from the gas origin by an amount increasing from 48 to 117 cm^{-1} as the temperature is lowered from the critical temperature to — 100°. This band is asymmetric, with a tail to the short wave side, and above 20° C. shows signs of being resolved into two bands, one in the position of the gas band. It is concluded that liquid HCl contains two types of molecules, one gas-like, the other, with the vibration frequency perturbed by intermolecular action. The variation of the perturbed frequency with temperature is partly consistent with the hypothesis that the perturbation originates in the electrostatic action of neighbouring molecules, but the magnitude of the shift is smaller by a constant amount than that produced by inert solvents of the same dielectric constant as liquid HCl. The gas a few degrees above the critical temperature and above the critical pressure also contains some liquid-like molecules. AUTHOR.

4053. Ions of Europium Distributed between Different Configurations in Homogeneous Solutions. S. Freed, S. I. Weissman, F. E. Fortess and H. F. Jacobson. *J. Chem. Phys.* 7. *pp.* 824–828, *Sept.*, 1939.—Changes in the environment of Eu ions in solution bring about changes in the structure of the absorption spectrum. For example, an aqueous solution of europium chloride upon having KNO_3 added to it gives rise to the structures in the spectra of europium nitrate, in addition to the spectrum of europium chloride. Structures in the spectra of Eu salts in alcohol differ from those in water. In a mixed solvent of water and alcohol both spectra are present with relative intensities which vary according to the relative amounts of the components. Europium chloride in the mixed solvent has a spectrum which cannot be distinguished from the exact superposition of the spectra of europium chloride in pure water and in pure alcohol. However, the spectrum of europium nitrate in the mixed solvent has its lines shifted from the positions they occupy in the spectra of the nitrate in the pure solvents. The shifts seem to vary continuously with the proportions of water to alcohol. Nevertheless, the lines remain sharp as successive amounts of water are added, with no suggestion that the lines are a blur, between the spectra of the limiting concentrations. The implications of these results are briefly discussed in their bearing upon the behaviour of electrolytes in mixed solvents. AUTHORS.

4054. Electron Vibration Spectrum of Neodymium Salt Crystals. K. H. Hellwege. *Zeits. f. Physik*, 113. 3–4. *pp.* 192–202, 1939.—The infra-red absorption spectrum of $Zn_3Nd_2(NO_3)_{12}24H_2O$ is measured and analysed in the region 25 to 58 μ and certain bands are interpreted as resulting from the superposition of crystal grating vibrating on electron transitions. From observations of the absorption spectra, using polarised light, transition rules as determined by symmetry considerations are derived; certain transitions are allowed only parallel or perpendicular to the optic axis of the crystal and others in both directions. The transition rules break down when a crystal vibration is superposed on the electron transition and the extent of the breakdown increases with the magnitude of the superposed vibration quantum. J. E. K.

4055. Assignment of Electronic Bands in Spectra of Solutions. Part III. G. Kortüm. *Zeits. f. phys. Chem.* 43. *Abt. B.* 6. *pp.* 418–431, 1939.—The fact that the organic nitro-compounds are chemically connected with HNO_2, HNO_3 and their derivatives, is demonstrated by their absorption bands. The spectra of all these molecules consist of a weak band at lower frequencies and an intense band at higher frequencies. The first can be assigned to a transition into an excited state while the latter is due to the photochemical disintegration of the molecule. From the spectral position of the band at long-wave lengths conclusions can be drawn about the tautomeric equilibrium of HNO_2 as the transition from one tautomeric form to the other is simultaneous with a change in the p-electron distribution. The contribution of the *a priori* possible electromeric structures to the stationary state of the molecules or ions can be estimated with the help of the spectra. The attempt to determine the relations between the band shift and the resonance energy of mesomeric systems leads only to an estimate of the order of magnitude of the energy difference. [For Part II see Abstract 3686 (1939).] L. K.

4056. Intensities of Electronic Transitions in Molecular Spectra. Part VIIIa. R. S. Mulliken. *J. Chem. Phys.* 7. *pp.* 570–572, *Aug.*, 1939.—Using the Hückel *LCAO* molecular orbital approximation, it is

found that the lowest excited electronic levels, long wave-length electronic spectra, and so on, should show exactly the same special features for conjugated polyene chain molecules with an *odd* as for those with an *even* number of atoms in the conjugated chain. Examples of even-numbered conjugated chain molecules are the carotenoids, discussed previously. Many dye molecules (for example, certain infra-red sensitisers) are salts whose positive ion is built on an odd-numbered conjugated chain with a N atom terminating the chain at each end. It seems probable that the explanation of the spectra of these dyes is essentially similar to that of the carotenoids, although much remains to be done toward understanding the effect of phenyl and other unsaturated groups when included in the conjugated chains. Absorption and refraction of carotenoid crystals are briefly discussed ; the predicted strong pleochroism and double refraction are known experimentally. Bearing of the papers of the present series on Raman intensities of conjugated chain molecules is briefly discussed. A correction is given of an error in papers VI and VII of this series. [See Abstract 2538 (1939).] AUTHOR.

4057. Calculation of Position and Width of Energy Bands of Na, K, Rb and Cs. P. Gombás. *Zeits. f. Physik*, 113. 3–4. *pp.* 150–160, 1939.—The calculations apply perturbation theory to the case of free electrons. The effects of polarisation of the ions by the valence electron and of the exchange interaction between this electron and those of the core are taken into consideration. The calculation is carried out by purely analytical methods without the use of numerical integration. The following results are obtained for the width of the bands Na 7·43, K 5·12, Rb 3·98, Cs 3·44 eV. The degree of freedom and the ratio of the acceleration of the metal electron to that of the free electron is also worked out with satisfactory agreement with experiment. J. E.

4058. Normal Vibrations and Configuration of Hydrazine. Part I. K. Schäfer. *Zeits. f. phys. Chem.* 43. *Abt. B.* 6. *pp.* 409–417, 1939.—Group theoretical methods are used to determine the normal vibrations active in the infra-red and Raman-spectrum of three possible configurations of the hydrazine molecule. A relative estimate of the intensities of the bands which are expected, is given for these configurations, *i.e.* the so-called tub-form, the zigzag form and an asymmetric form in which one NH_2-group is rotated with respect to the other by 90° about the N-N axis. L. K.

4059. Absorption of Continuous Spectrum of Xenon Tube Excited in White Light. M. Laporte. *Comptes Rendus*, 209. *pp.* 95–98, *July* 10, 1939.—It has been previously shown that the intensity of the continuous spectrum emitted by a xenon tube excited in white light is independent of the direction of emission [see Abstract 3605 (1937)]. This suggests that the coefficients of absorption of the gas for its own radiations are feeble at least in the visible. Details are given of the arrangements and theory of a method of measuring these coefficients. A value obtained in the red is 0·075 cm.$^{-1}$. Coefficients for other regions have been obtained by Gans [see following Abstract] by spectrophotometry from this result. J. E.

4060. Self-Absorption of Continuous Spectrum of Xenon Tube Excited in White Light. F. Gans. *Comptes Rendus*, 209. *pp.* 98–100, *July* 10, 1939.—Self-absorption increases with decrease of wave-length. It is shown how, knowing the relative intensity of emission of the tube

viewed endways and sideways, together with the absorption coefficient for one wave-length, it is possible to determine by spectrophotometry the absorption coefficients for any other wave-length. A curve showing absorption coefficient against wave-length shows a slow increase between 6500 and 5000 Å and an increasingly rapid rise towards the short-wave end. [See preceding Abstract.] J. E.

4061. Infra-Red Luminescence of Rare Elements. Analytical Application. M. Servigne. *Comptes Rendus*, 209. *pp.* 210–212, *July* 24, 1939.—Using a modification of previous technique [see Abstract 2913 (1939)] which extended the measurements to 12000 Å the photoluminescence of Nd and Pr, embedded as oxides in $CaWO_4$ has been detected and is characterised by bands lying beyond 8000 Å, entirely for Nd and partially for Pr. A specimen of natural $CaWO_4$ was examined for visible, u.v., and infra-red luminescence impurities. The sensitiveness of the infra-red luminescence spectrum of Nd is much greater than the sensitiveness of its arc spectrum. W. R. A.

4062. Electrodynamic Splitting of Spectral Lines of Neon and its Isotopes. L. Glaser. *Preuss. Akad. Wiss. Berlin, Ber.* 28. *pp.* 310–328, 1938.—The author describes a method for investigating the Zeeman, Stark and Paschen-Back effects in which the light source is placed in crossed electric and magnetic fields. The splitting of the lines then observed is termed electrodynamic splitting. The method is applied to the study of Ne and its isotopes. W. S. S.

4063. Paschen-Back Effect. Part VI. Ne Spectrum. J. B. Green and J. A. Peoples, Jr. *Phys. Rev.* 56. *p.* 385, *Aug.* 15, 1939.—A correction to the original. [See Abstract 3325 (1939).]

4064. Coherence of Circular Components in the Stark Effect. F. Suppe. *Zeits. f. Physik*, 113. 1–2. *pp.* 18–27, 1939.—The Stark effect is investigated by observing the influence of electric fields on the polarisation of Hg resonance radiation. Some observations are also made in combined electric and magnetic fields. In the cases of separate excitation of π- and σ-components in an electric field there is no change in the polarisation and it is proved that the circular components in the Stark effect are coherent. J. E. K.

4065. Raman Effect in Camphor. B. M. Anand and S. Narain. *Indian Journ. Phys.* 13. *pp.* 159–165, *June*, 1939.—The Raman spectrum of camphor has been studied in the crystalline state and in its saturated solutions in CCl_4, CS_2, $CHCl_3$, CH_3OH and CH_3COOH. The characteristic Raman frequencies of camphor in the solid state are 512, 653, 1182, 1450, 1738 and 2937 cm^{-1}. When dissolved in the first three solvents, about 20 frequencies, including the above, are observed. In the last two solvents the number of lines observed is small. Important Raman frequencies are ascribed to the corresponding vibrations in the camphor molecule. AUTHORS.

4066. Raman Spectrum of Ortho-Diphenyl-Benzene. S. K. Mukerji and S. A. Aziz. *Indian Journ. Phys.* 13. *pp.* 211–217, *June*, 1939.—Results of the study of the Raman spectrum of *o*-diphenyl-benzene have been recorded for the first time in this paper. By employing suitable filters with the purest substance in the molten state and taking other precautions very clean spectra were obtained though the continuous background due to fluorescence still persisted. The substance has yielded 33 new lines. Seven anti-Stokes lines corresponding to frequencies 993, 708,

615, 406, 359, 238 and 144 cm^{-1}. have been observed. The results are discussed with reference to the Raman spectra of benzene and diphenyl.
AUTHORS.

4067. Raman Spectra of Crystalline Powders. E. Canals and H. Collet. *Comptes Rendus*, 209. *pp.* 212–214, *July* 24, 1939.—Raman spectra for powdered $MgSO_4,xH_2O$ ($x=7,6,1$), Na_2HPO_4,xH_2O ($x=12,7,2$), and $CuSO_4,xH_2O$ ($x=5,3$) are recorded and discussed. W. R. A.

4068. Infra-Red and Raman Spectra of Dimethyl Acetylene. B. L. Crawford, Jr. *J. Chem. Phys.* 7. *pp.* 555–562, *Aug.*, 1939.—The infra-red absorption of gaseous C_4H_6 has been measured from 2 to 24 μ, and the Raman spectrum of the liquid studied. Analysis of the data permits the determination of all the fundamental frequencies of the molecule. The frequencies are fitted closely with a modified valence-force potential function in which the methyl-group force constants are those previously determined for ethane. AUTHOR.

***4069. Spectrograph for Ozone Determination. M. W. Chiplonkar.** *Indian Acad. Sci., Proc.* 9*A*. *pp.* 504–507, *June*, 1939.—A simple prism spectrograph incorporating a cylindrical lens is described, suitable for the photometric determination of the amount of O_3 in the air layers near the ground. Some preliminary results obtained with the instrument are given. A. H.

4070. H.F. Discharges and their Application to Molecular Spectroscopy. P. Mesnage. *Ann. de Physique*, 12. *pp.* 5–87, *July–Aug.*, 1939.—H.f. discharge without electrodes has been utilised as a source for exciting band spectra, and is applicable preferentially to relatively labile molecules which any other discharge would destroy completely. The compounds studied were on the one hand the halogen salts of the iron family of metals: $FeCl_2$, $FeBr_2$, $NiCl_2$, $NiBr_2$, $CoCl_2$, $CoBr_2$, $MnCl_2$, $MnBr_2$, $CrCl_3$, whose molecular spectra are now described for the first time; and on the other hand the iodides of the alkaline earths whose spectra are also new. The salt was placed in a cylindrical tube in the axis of a solenoid traversed by h.f. current (of about 10 m. wave-length and 100 W power). The presence of Ne is practically necessary for the maintenance of the discharge, and a special heating arrangement is described for the vaporisation of the salt. The molecular spectra obtained from each salt indicated that the diatomic molecule MX accounted for the larger part and not the complete molecule MX_2. A common characteristic of these spectra is their extreme complication, and the absence of well developed systems, the principal regularities being the sequences of bonds. The best developed systems were found with MnCl and FeCl and were situated in the near u.v.; they contain a term of sextriplets which is the first high multiple term found experimentally in the band spectra. The systems for Ca I, Sr I and Ba I were in the visible blue and have been separated and measured for the first time. There is a single system for Ca I, two systems for Sr I which form a large doublet, and two systems reduced at their principal sequence for Ba I. H. H. Ho.

See also Abstracts 3984, 3998, 4099, 4100.

TRANSMISSION.

4071. Relativistic Doppler Effect. R. C. Jones. *J.O.S.A.* 29. *pp.* 337–339, *Aug.*, 1939.—The theory of the recent experiment of Ives and Stilwell [see Abstract 3541 (1938)] is developed on the basis of the special theory of relativity. The predictions are shown to be identical

with those obtained from electron theory. A possible source of error in the experiment is pointed out, and a method for its elimination is suggested. AUTHOR.

See also Abstract 4179.

X-RAYS.

4072. X-Ray Dispersion and Atomic Electron Cloud Distortion in Zinc Crystals. E. M. McNatt. *Phys. Rev.* 56. *pp.* 406–413, *Sept.* 1, 1939.—Monochromatic X-rays of wave-lengths 1·54 Å (Cu Kα) and 1·433 Å (Zn Kα) were diffusely scattered at angles ϕ varying from 24° to 120° from single crystals of zinc ($\lambda_I = 1{\cdot}28$ Å) whose orientation angles ψ were 0° and 90°. The intensity of the diffusely scattered rays was found to vary with $(\sin \frac{1}{2}\phi)/\lambda$ according to Jauncey's theoretical formula for the region of wave-lengths close to the K critical absorption wave-length of the scattering crystal. In the case of the scattering of Cu Kα rays the decrement Δf in the atomic structure factor was 2·5 as compared with Hönl's value of 2·3. For the less intense Zn Kα rays Δf was 3·65 as compared with Hönl's value of 2·8. The difference in the latter case is probably due to experimental error. More interesting was the "dip" or "valley" found in the diffuse scattering $S(\psi = 0°)$ values in the region of $(\sin \frac{1}{2}\phi)/\lambda = 0{\cdot}3A^{-1}$. After considering various possible causes for this dip, it was finally decided that the cause of the dip is a corresponding dip in the atomic structure factor $f(\psi = 0°)$ values in this region. The maximum difference, $f(\psi = 90°) - f(\psi = 0°)$ is about 6 electrons. This is greater than the previous value of 2·4 electrons and indicates a larger and deeper distortion of the electron cloud of a zinc atom in the crystal than had previously been imagined. AUTHOR.

4073. Absorption of Monochromatic X-Rays in CS_2, CH_2Cl_2, C_2H_5Br and CH_3I. H. Hansen. *Ann. d. Physik*, 35. 6. *pp.* 524–546, *July*, 1939.—The mass absorption coefficients of CS_2, $CHCl_2$, C_2H_5Br and CH_3I for monochromatic X-rays between 0·1623 and 1·933 Å have been measured by the method described by Küstner [see Abstract 3847 (1931)]. In the case of the first 3 compounds the liquid form was used for short wave lengths and the gases for longer, but CH_3I was used in gaseous form throughout. The absorption cells and the density determinations are described in considerable detail. From the results for the compounds the mass absorption coefficients for I, Br, Cl and S are calculated. In the case of I and Br, a direct $C\lambda^n$ formula is obtained, scatter being negligible. For Cl and S, however, the curves of log μ/ρ against log λ show distinct curvature, and the total absorption is analysed into photoelectric and Compton scattering absorption, by the method of Küstner and Trubestein [see Abstract 2145 (1937)]. Comparison of the results with those of other workers shows very good agreement, and it is suggested that the mass absorption coefficients of Cl and S may be regarded as known to within 1% from 0·162 to 9·868 Å. J. E. R.

4074. X-Ray Resonance Absorption Lines in the Argon K-Spectrum. L. G. Parratt. *Phys. Rev.* 56. *pp.* 295–297, *Aug.* 15, 1939.—Recorded with a two-crystal vacuum spectrometer, the absorption curve for A gas near the K-absorption edge, 3866 X.U., is analysed in terms of the main edge and the $1S \rightarrow nP$ ($n > 3$) series of resonance lines absorption. The main edge is determined uniquely as follows: the wave-length position is taken as at the series limit; the width is obtained from the measured width of the most intense absorption line; and the shape is given by the

theoretical arctangent curve. The wave-length positions of all the resonance absorption lines are taken from the optical terms of K and, with the width and shape of each line known, the various members of the series $1S \rightarrow nP$ are determined uniquely. The relative intensities of these lines are 100 : 34 : 18 : 8·5, etc. This analysis illustrates the type and completeness of the analysis desirable for solid absorbers, but, unfortunately, the definition and meaning of the main edge of a solid absorber are rather obscure. AUTHOR.

4075. X-Ray K-Absorption Edges of Fe (26) to Ge (32). W. W. Beeman and H. Friedman. *Phys. Rev.* 56. *pp.* 392–405, *Sept.* 1, 1939.—The structures of the X-ray K-absorption edges of the elements Fe to Ge have been measured with a double-crystal spectrometer. Measurements were extended about 20 V beyond the main edge in each case. In the regions of secondary structure, new maxima and minima have been resolved, and their intensities compared with results obtained photographically. The two sets of measurements are found to disagree much more than could be expected from the estimated precisions. Wave-length positions of the first empty levels above the Fermi distribution have been assigned with a probable error of less than 0·1 X.U., and widths of K states have been determined to within half a volt by matching theoretical arctangent curves to the experimental edges. Previously measured $K\beta_{2,5}$ emission lines have been plotted with the corresponding absorption edges and the shapes of both lines and edges explained on the basis of distributions of states in the electronic energy bands of these metals. The $K\beta_5$ line is interpreted as a dipole transition arising from the mixture of p function in the $3d$ bands. Quantitative agreement is obtained in a correlation of the observed Cu emission and absorption structures with the recently calculated electronic bands of this metal. AUTHORS.

4076. Intensities of K-Series X-Ray Lines of W and Pt. W. H. Kliever. *Phys. Rev.* 56. *pp.* 387–391, *Sept.* 1, 1939.—Measurements of the relative intensities of the $K\alpha$ and $K\beta$ lines of $_{74}W$ and $_{78}Pt$ have been made with a double-crystal spectrometer, high pressure argon ionisation chamber, and FP-54 Pliotron amplifier by measuring with a planimeter the areas under the curves of the lines graphed against Bragg angle. The results in the $_{78}$ Pt spectrum, which are the more reliable, are : on the basis 100 for the intensity of $K\alpha_1 : K\alpha_2 = 52$, $K\beta_3 = 10{\cdot}2$, $K\beta_1 = 20{\cdot}0$, $K\beta_5 = 0{\cdot}38$, $K\beta_2 = 7{\cdot}8$, $K\beta_4 = 0{\cdot}8$, $(O_{II}\,O_{III}\text{–K}) = 1{\cdot}2$. Although the intensity of the quadrupole line $K\beta_5$ relative to $K\beta_1$ is in good agreement with the calculated value of Massey and Burhop, the predicted decrease in the relative intensity of this line at lower atomic numbers does not seem to be experimentally verified. The observed relative intensities of the stronger dipole lines seem to agree satisfactorily with the calculations of Pincherle and of Massey and Burhop. AUTHOR.

***4077. 10 kW Rotating-Anode X-Ray Tube : Structure of Salt Solutions. J. Beck.** *Phys. Zeits.* 40. *pp.* 474–483, *July* 15, 1939.—A description with detailed diagrams is given of a large X-ray tube with rotating anode which will run continuously at 10 kW. By means of the powerful X-ray beam obtained from this tube the author has investigated the scattering from aqueous solutions of LiCl, LiBr and RbBr in concentrations up to the maximum. The results are not compatible with the irregular distribution of ions in the solution but rather with the ions built into a distorted lattice composed of water molecules. In high concentrations this then goes over into a lattice similar to that of a solid hydrated salt. J. I.

HEAT.

CALORIMETRY.

*** 4078. Specific Heat of Gases at High Temperatures. R. W. Fenning and A. C. Whiffin.** *Roy. Soc., Phil. Trans.* 238*A*. *pp.* 149–212, *July* 12, 1939.—The explosion method was employed. A direct measurement of the heat loss to the explosion vessel walls was avoided. The experimental apparatus is fully described and detailed drawings are provided. The explosion vessel consisted of a hollow steel sphere, made up in halves connected together by means of a flanged joint. The manometer is connected to the lower half. The vessel is surrounded by a gun-metal casing, the intervening space forming a "jacket" which can be supplied with steam. The method of calibrating the manometer, of determining the mixture composition and the technique for the addition of water vapour to certain gas mixtures are given. The determination of the compressibilities of the gases is described in a supplement [see Abstract 4090 (1939)]. The gases investigated were CO, N_2, CO_2, H_2 and H_2O (vapour). The values obtained for the mean molecular heats are represented graphically, and the equations of the curves are stated. There is fairly close agreement between these results, and the molecular heat values obtained by other investigators from spectroscopic data. S. W.

*** 4079. Adiabatic High-Temperature Calorimeter for Alloy Research. O. Kubaschewski and A. Walter.** *Zeits. f. Elektrochem.* 45. *pp.* 630–636, *Aug.*, 1939.—A calorimeter has been developed for determining the heat liberated during the formation of an alloy. The apparatus contains, besides the calorimeter, a heating element and a thermostat. Its water value is of the order of 1000 cal/ °C, and it can be used up to 700° C. The rise of temperature in the calorimeter during a reaction is measured by a Pt-thermometer. The accuracy of the apparatus is discussed; with a liberation of 1·5 kg. cal. during a reaction the maximum error is $\pm$ 2·5 %. G. E. A.

CONDUCTION.

4080. Thermal Conductivity of Liquids. I. Osida. *Phys. Math. Soc. Japan, Proc.* 21. *pp.* 353–356, *June*, 1939. *In English.*—A theoretical discussion of thermal conduction in liquids, based on a simple model of a liquid similar to that proposed by Andrade in connection with his theory of viscosity. The molecules in the liquid are regarded as executing vibrations as in the solid state, but the amplitudes of the vibrations are so large that the molecules collide with neighbours at every extreme displacement. At such a collision translational and rotational energy is exchanged. It is assumed that the frequency of intermolecular vibration for the liquid is the same as for the solid, and Lindemann's formula is used to evaluate the frequency. The relation $k = 3{\cdot}1 \times 10^{-3}\, T_m^{\frac{1}{2}}/M^{\frac{1}{3}}V^{2/3}$ cal. cm^{-2}. deg^{-1}. is derived for the thermal conductivity, T_m being the absolute temperature of the melting point, M the molecular weight and V the volume. The conductivities for several liquids calculated according to this relation are in satisfactory agreement with the observed values. S. W.

4081. Solutions of Heat Equation. S. Täcklind. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 26*B*. 12. [7 *pp.*], 1939. *In French.*—This mathematical paper commences with a discussion of solutions of the heat equation $\partial^2_s\partial_x{}^2 - \partial_s\partial_s = 0$. The author then considers the following theorems:

(1). If M(y) be a continuous and non-negative function for every value of $y < 0$, it is necessary and sufficient that $lim_{y=-\infty} M(y) = 0$, in order that every solution z (x, y) of the heat equation in the hemi-plane $y < 0$, and which fulfils the condition $| z (x, z) | < e^{M(x)|x|}$ for all values of x and of $y < 0$, may be a constant. (2). If ϵ (x) be a continuous and non-negative function for $x > 0$, and if z (x, y) be a solution of the heat equation which at every point of the hemi-plane $y < 0$ satisfies the inequality $| z (x, z) | < e^{\epsilon(|x|)|x|^2}$ and if $lim\, \epsilon_{x=\infty} (x) = 0$, then z (x, y) may be written $z (x, y) = C_1 + C_2 (x)$, C_1 and C_2 being constants, which is not always possible if the above limit > 0. H. H. Ho.

4082. Large-Scale Thermal Conductance Apparatus for Testing Building Materials. J. D. Babbitt. *Canad. J. of Research*, 17. *Sect.A. pp.* 164–177, *Aug.*, 1939.—A short description and discussion are given of a thermal conductance apparatus of the guarded hot-box type used by the National Research Laboratories, Ottawa, for the measurement of the thermal conductivity of building materials. Results obtained with this apparatus are compared with hot-plate measurements on the same materials and indicate good agreement between the two methods. AUTHOR.

See also Abstract 4122.

CONVECTION.

4083. Turbulence in Convection in Gases Between Concentric Vertical Cylinders. L. Onsager and W. W. Watson. *Phys. Rev.* 56. *pp.* 474–477, *Sept.* 1, 1939.—In a thermal diffusion apparatus consisting of two concentric vertical metal cylinders the temperature of the inner hot cylinder is measured for constant power input in the heater as a function of the pressure of the contained gas (N_2 or CO_2). The change from lamellar convection flow to turbulence produces sharply at a certain pressure a cooling which increases with further rise in the gas density. For this critical density the ratio of the remixing by convection to that by diffusion as well as the Reynolds numbers are computed. The latter are around 150; *i.e.*, about $\frac{1}{10}$ the values found for flow through pipes. With increasing temperature difference a minimum value of the pressure for onset of turbulence is found. In order to insure lamellar convection flow in isotope separation by thermal diffusion, conditions should be adjusted so that the ratio of the two remixing effects is not more than $\frac{1}{10}$ these critical values. AUTHORS.

DILATATION.

4084. Thermal Expansion of Simple Liquids. A. Harasima. *Phys. Math. Soc., Japan, Proc.* 21. *pp.* 398–402, *July*, 1939. *In English.*—Using the model proposed [see Abstract 2948 (1939)] in explaining the phenomenon of fusion, the coefficient of thermal expansion is obtained. The expression $BT_m = 0{\cdot}115$ is obtained, where B is the coefficient of cubical expansion and T_m is the melting temperature. Observed values of BT_m for many simple liquids are of the order of $0{\cdot}1$. AUTHOR.

4085. Length Changes and Endothermic and Exothermic Effects during Heating of Flint and Aluminous Clays. R. A. Heindl and L. E. Mong. *Bureau of Standards, J. of Research*, 23. *pp.* 427–442, *Sept.*, 1939.—Changes in length on heating from room-temperature to 1000° C. and the temperatures at which endothermic and exothermic effects occurred were determined on flint clays from Kentucky,

Missouri, Ohio, Pennsylvania, and Washington ; on a plastic clay from Pennsylvania ; on a hard kaolin and a bauxitic clay from Georgia ; and on a Zettlitz kaolin and a diaspore from Missouri. Changes in the length of granular pieces and of pulverised materials were measured both in air and in an atmosphere of the products of gas combustion. The two ranges of temperature (approximately 500° to 600° C. and 925° to 980° C.) in which very rapid contraction took place during heating were the same as those in which endothermic and exothermic reactions, respectively, occurred. The ranges of temperature in which rapid contraction took place were slightly lower for the pulverised than for the granular pieces of the clays, except for the Missouri clay, in which there was no difference. AUTHORS.

TEMPERATURE.

See also Abstracts 3927, 4089, 4108.

THERMOCHEMISTRY.

4086. Heat of Decomposition of Chlorine Trioxide, and the Energy of the Oxygen-Chlorine Bond. C. F. Goodeve and A. E. L. Marsh. *Chem. Soc., J. pp.* 1332–1337, *Aug.*, 1939.—A value of $\Delta H_{15^\circ} = -37 \times 2$ kg.cal./mol. has been obtained for the heat of the reaction $ClO_3 \rightarrow \frac{1}{2}Cl_2 + 1\frac{1}{2}O_2$, and the heats of decomposition of all the oxides of Cl are now known. A value of 52 ± 1 kg.cal. has been calculated for the normal 2-electron O-Cl bond energy in the chlorine oxides. The Cl_2O molecule is weakened to the extent of about 10 kg.cal. by a strain in the O angle, and the Cl_2O_7 molecule is weakened to a slightly greater extent. The strengthening influence of the odd electron in chlorine tri- and di-oxide has been calculated to be about 11 and 15 kg.cal. respectively. It has been deduced that the heat of decomposition of ClO into atoms is about 67 kg.cal. Applications of the thermochemical data to the kinetics of the reactions of the oxides of Cl are discussed. AUTHORS.

4087. Calculation of Bond Strength in Methane. H. A. Taylor and M. Burton. *J. Chem. Phys.* 7. *pp.* 572–573, *Aug.*, 1939.—A recomputation has been made of the C — H bond strength in CH_4 by the method of Voge, using more recent data. The premises on which the calculations are based have been examined and it is concluded that the recalculated value ($\sim$ 103 kg.cal.) is in good agreement with the value of 94·8 kg.cal. given by Burton [see Abstract 253 (1939)] when the approximations used in the Voge method are taken into account. AUTHORS.

4088. Aerodynamics of Reacting Substances. H. Bateman. *Nat. Acad. Sci., Proc.* 25. *pp.* 388–391, *July*, 1939.—Equations derived from a very general type of variational principle and Lavoisier's principle of the indestructibility of mass, and applicable to the determination of the velocity and properties of a surface of discontinuity in the atmosphere or in an explosion engine, are discussed. J. S. G. T.

4089. Temperature of Hydrocarbon Flames. J. van de Poll and T. Westerdijk. *Comptes Rendus*, 209. *pp.* 158–160, *July* 17, 1939.—Difficulties encountered with the use of the crater of a C arc as a source of high temperature in the Féry optical method of determining the temperature of flames are overcome by using a different optical arrangement. The effect of Na in the arc is eliminated. The method is applied to the determination of the temperature of flames of propane-oxygen mixtures. A. J. M.

THERMODYNAMICS.

***4090. Compressibility of Gases. R. W. Fenning and A. C. Whiffin.** *Roy. Soc., Phil. Trans.* 238*A*. *pp.* 213–228, *July* 12, 1939.—In connection with the authors' determination of the specific heat of gases [see Abstract 4078 (1939)], information was required on the compressibility characteristics of gas mixtures at medium pressures. In this supplement a description is given of the apparatus designed and used for the purpose, the particulars of its calibration, and examples are given of the departure of certain gas mixtures from the ideal state both at 20 and 100° C. The method employed for determining the pressure and volume changes was that in which a vessel of known volume is charged with the gas or gas mixture to the required upper pressure and its contents expanded to atmospheric pressure and their volume measured. The apparatus is regarded as being suitable for work of high precision provided it is used in conjunction with sufficiently sensitive temperature and pressure measuring instruments. S. W.

4091. Effect of Compression on Homogeneous Systems Ethylene and Air-Ethylene in Critical Region. R. L. McIntosh, J. R. Dacey and O. Maass. *Canad. J. of Research*, 17. *Sect.B. pp.* 231–240, *Aug.*, 1939.—The effect of compression, due to the thermal expansion, on the density of the systems ethylene and air-ethylene in the critical region has been studied. Apparently stable heterogeneous systems, as detected by density measurements, are re-formed by this treatment. The significance of these experiments in relation to critical phenomena is discussed, and an explanation based on a concept of the mutual dispersion of the two phases is suggested. AUTHORS.

4092. Corresponding States for Perfect Liquids. K. S. Pitzer. *J. Chem. Phys.* 7. *pp.* 583–590, *Aug.*, 1939.—On the basis of certain assumptions concerning the properties of the molecules, and by using classical statistics, the van der Waals theory of corresponding states is derived. No mathematical approximations are involved. A, Kr and Xe, which conform closely to the assumptions, show the expected correspondence in behaviour and are taken as standards. The name *perfect liquid* is suggested for this behaviour. In a second part, the deviations from perfection are discussed for a wide variety of substances. Particularly considered are heat capacities and entropies of vaporisation which should be compared at points where the vapour to liquid volume ratio has the same value. The observed deviations are explained in a general way. AUTHOR.

4093. Equations of State of Frozen Ne, A, Kr, and Xe. G. Kane. *J. Chem. Phys.* 7. *pp.* 603–613, *Aug.*, 1939.—The interaction between two rare-gas atoms is assumed to have the form $-Ar^{-6} + AB\exp(-r/\rho)$. The values of A and B are found from the lattice distances and the heats of sublimation of frozen Ne, A, Kr + Xe for $\rho = 0{\cdot}2091$ Å and $\rho = 0{\cdot}345$ Å. The equations of state of the solids are then calculated, including the Debye θ's and the breakdown points, which occur a few degrees below the melting points. For Kr the expansion coefficient and the specific heat are calculated, but are found too high at higher temperatures. AUTHOR.

4094. Theory of the Solid State and of the Melting Point. G. Molière. *Ann. d. Physik*, 35. 7. *pp.* 577–596, *Aug.*, 1939.—The different thermodynamic states of simple systems are investigated by methods based on classical (statistical) mechanics, and for the characterisation of the various macro-states of the systems considered use is made of the

Debye distribution function for common molecular conditions. These methods are first developed for monatomic substances and extended to polyatomic substances later in the paper. A new derivation of the Grüneisen equation of state for solids is given, whereby a simple expression for the Grüneisen constant γ has been obtained. The theory is then somewhat empirically extended so as to include deviation from the Dulong-Petit law—this extension is not on quantum lines but from the standpoint of mutual coupling and anharmonicity of the lattice vibrations. The theory is finally developed to include a statistical consideration of fusion and of the liquid state. H. H. Ho.

4095. Thermodynamics of Crystals and Melting. M. Born. *J. Chem. Phys.* 7. *pp.* 591–603, *Aug.*, 1939.—The Helmholtz free energy, A, of a rigid body is a function of temperature, and of the six homogeneous strain components. If the crystal is to be rigid, three inequalities must be satisfied for the derivatives of A with respect to the six strain components, for a regular (cubic) lattice. This enables one to limit the pressure–temperature range for which the crystal is stable. The violation of the condition $c_{44} > 0$, that the crystal resist shearing, is interpreted as leading to melting. From a knowledge of the forces between the molecules the phase integral, and therefore the free energy, may be calculated as a function of T, V, and the six strain components. The numerical calculations are carried out for a body-centred cubic lattice. The product of all the frequencies is calculated directly, so that the assumption that the Debye equation for the frequency distribution holds, is not necessary. The melting curve, pressure against temperature, is then determined. AUTHOR.

4096. Melting as an Order-Disorder Transition. G. H. Wannier. *J. Chem. Phys.* 7. *pp.* 810—817, *Sept.*, 1939.—In this paper the breakdown of a regular crystal pattern is studied for an atomic crystal of the diamond type. For practical reasons, the forces between the atoms are idealised into potential wells. It is then possible to study the motion of a limited number of particles. The lattice structure is introduced as long distance order in the manner developed by Bethe. The results show the existence of a phase transition where this long range order breaks down. Considerable thermodynamic inconsistencies are detected, however, and the reasons for these discrepancies are discussed. AUTHOR.

4097. Behaviour of Matter at Extremely High Temperatures and Pressures. F. Cernuschi. *Phys. Rev.* 56. *pp.* 450–455, *Sept.* 1, 1939.—After some critical remarks on the current notions of stellar neutron cores the suggestion is set forth that an assembly of neutrons can form, under specified circumstances, two different phases by reason of the attracting forces between neutrons. The hypothetical transition from the dilute to the condensed neutron phase affords a concrete physical basis for the idea advocated by Zwicky that the supernovæ originate from the sudden transition of an ordinary star into a centrally condensed one. [See Abstract 779 (1937).] AUTHOR.

4098. Thermal Properties of Ortho- and Para-Hydrogen and Ortho- and Para-Deuterium. K. Cohen and H. C. Urey. *Zeits. f. phys. Chem.* 43. *Abt.B.* 6. *pp.* 432–438, 1939.—The authors defend their point of view that the splitting up of the degeneracy of the ortho-state cannot be made responsible for the vapour-pressure differences between o–H_2 and p–H_2 (or between p–D_2 and o–D_2) at temperatures above 14° K.

They show that Schäfer's theory [see Abstract 1723 (1939)] is not in agreement with the experimental data. L. K.

4099. Rotational Partition Function of the Water Molecule. C. C. Stephenson and H. O. McMahon. *J. Chem. Phys.* 7. *pp.* 614–615, *Aug.*, 1939.—The rotational contribution to the partition function of the water molecule has been computed for temperatures up to 298·1° K. by summing the experimental energy levels of Randall, Dennison, Ginsburg and Weber [see Abstract 4525 (1937)]. The results are compared with those of a rigid rotator and in this way the "stretching" contribution is determined. Wilson's theoretically deduced stretching correction [see Abstract 4286 (1936)] compares very favourably with the values obtained by summing energy states. AUTHORS.

4100. Thermodynamic Properties of HF and F_2 from Spectroscopic Data. G. M. Murphy and J. E. Vance. *J. Chem. Phys.* 7. *pp.* 806–810, *Sept.*, 1939.—Spectroscopic data have been used to calculate the free energy, entropy and heat capacity of diatomic HF between 298·1° and 2000° K. The required spectrum of F_2 is not known but from electron diffraction data and Badger's rule, enough information has been obtained to make similar calculations to the harmonic oscillator—rigid rotator approximation. The errors in the thermodynamic quantities due to the uncertainties in the vibrational frequency and moment of inertia have been estimated. Combination of these results with thermal data has resulted in values of the free energy change of the reactions: $1/2H_2 + 1/2F_2 \rightleftharpoons HF$ and $F_2 \rightleftharpoons 2F$. AUTHORS.

4101. Thermodynamics of Chlorine. W. F. Giauque and T. M. Powell. *Am. Chem. Soc., J.* 61. *pp.* 1970–1974, *Aug.*, 1939.—The heat capacity of solid and liquid Cl_2 has been measured from 14° K. to the boiling point. The melting and boiling points were found to be 172·12 and 239·05° K., respectively (0° C. = 273·10° K.). The heat of fusion is 1531 cal. mole^{-1} and the heat of vaporisation at the boiling point is 4878 cal. mole^{-1}. The vapour pressure of liquid Cl_2 has been measured and the results represented by the equation: triple point 172·12 — 240° K., $\log_{10} P$ (int. cm. Hg) $= -(1414{\cdot}8/T) - 0{\cdot}01206\ T + 1{\cdot}34 \times 10^{-5}\ T^2 + 9{\cdot}91635$. The observed triple point pressure was found to be 1·044 cm. The entropy of Cl_2 was found to be 51·56 and 53·32 cal. deg.$^{-1}$ mole^{-1} at 239·05 and 298·10° K., respectively, for the ideal gas by means of the third law of thermodynamics. The data are in excellent agreement with a calculation based on band spectrum data giving 51·55 and 53·31 cal. deg.$^{-1}$ mole^{-1} at the two temperatures. AUTHORS.

4102. Thermodynamic Functions for a Fermi-Dirac Gas. E. C. Stoner. *Phil. Mag.* 28. *pp.* 257–286, *Sept.*, 1939.—A detailed account is given of the thermodynamical statistical relations for a perfect Fermi-Dirac gas. The properties of the main thermodynamic functions are summarised with particular reference to the convenience and appropriateness of different sets of variables in terms of which they can be expressed. The derivation of the essential statistical formulæ for a system of particles subject to Fermi-Dirac statistics is outlined. The formulæ are then specialised for the particular energy distribution of states characteristic of a perfect gas (with the energy density of states proportional to the square root of the energy). Expressions are obtained for the thermodynamic functions energy E, total heat H, Helmholtz free energy F, Gibbs free energy G, and entropy S, in terms of the basic Fermi-Dirac integrals, $F_{1/2}(\eta)$ and $F_{3/2}(\eta)$, which have previously been evaluated. Suitably reduced

forms of these functions, such as E/NkT or $E/N\epsilon_0$, are unique functions of a reduced temperature $\tau = kT/\epsilon_0$, where ϵ_0 is the Fermi zero energy (th maximum particle energy at absolute zero) proportional, for a system of fre particles, to $(1/m)(N/V)^{2/3}$, where m is the particle mass, V the volume o the system. Numerical tables are given of reduced forms of E, F, G an S for the range $0 \cdot 0 \leqslant \tau \leqslant 2 \cdot 0$, at intervals of $0 \cdot 05$ in τ, with numerica factors for converting from the τ to the T scale for atoms and electrons Series representations are also developed which are applicable for $\tau \rightarrow$ (approach to the Fermi-Dirac limit) and $\tau > 1$ (approach to the quasi classical limit), and convenient for numerical calculations for $\tau \leqslant 0 \cdot 1$ an $\tau \geqslant 1 \cdot 5$. The general character of the temperature variation of the variou thermodynamic functions is shown in three figures, and the behaviour a low temperatures is discussed in relation to Nernst's heat theorem, and t the range of validity of the quasi-classical approximations. The variou physical fields of application of the theoretical results are indicated.

AUTHOR

4103. Intramolecular Diffusion, Quantum Theory, and Calculation of Unimolecular Velocity-Constants. J. A. Christiansen. *J. Chem. Phys.* 7. *pp.* 653–656; *Disc.*, 656, *Aug.*, 1939.—The interna rearrangement of molecules can be considered as the diffusion from on part of a potential energy surface to another. It is suggested that th ordinary diffusion equations might be applied to these cases. The view point is alternative to the method of the activated state. An attempt is made to place this approach on a quantitative basis and to treat it with the help of quantum theory. AUTHOR

See also Abstracts 3840, 4084.

VAPORISATION AND CONDENSATION.

***4104. Vacuum Arc Mercury Still for Laboratories. M. V Sivaramakrishnan.** *Indian Journ. Phys.* 13. *pp.* 205–207, *June*, 1939.— An apparatus for distilling mercury is described. Current flows through a short mercury arc and by the heat thus generated the mercury is heated and vaporised and is finally condensed in a water-cooled condenser con nected to the middle of the arc. AUTHOR

***4105. Condensation of Supersaturated Vapours on Ions. L Scharrer.** *Ann. d. Physik*, 35. 7. *pp.* 619–637, *Aug.*, 1939.—The con densation of supersaturated vapours of H_2O, ethyl and methyl alcohols benzene, CCl_4, chloroform, chlorobenzene, and mixtures of ethyl alcoho and H_2O, and chloroform and H_2O on nuclei, natural ions, and ions pro duced by X-rays was investigated in a specially constructed cloud-chambe (described). The expansion ratios and degrees of supersaturation for each vapour are given and discussed. H_2O and chlorobenzene vapours con dense more readily on negative than on positive ions, and ethyl and methy alcohol, and chloroform vapours more readily on positive ions. Benzene and CCl_4 vapours condense equally well on either. The expansion value o ethyl alcohol-water mixtures for either type of ion is less than the value fo pure alcohol. The theory of condensation on ions is discussed. A. J. M

4106. NaCl Solutions as an Isopiestic Standard. A. A. Janis and J. B. Ferguson. *Canad. J. of Research*, 17. *Sect. B. pp.* 215–230, *Aug.*, 1939. A method is described for the accurate determination of the vapour pressure of aqueous solutions of non-volatile salts. Solutions o two salts contained in a large silver dish are rocked in an evacuated

desiccator until equilibrium is attained, then the vapour pressure of the one solution is determined from the known vapour pressure of the other. Results on the rate of attainment of equilibrium are given for various types of containers. NaCl is chosen as the standard. Results are given for the system NaCl-KCl at 25° C., 30° C., and 35° C. Since there is a disagreement amongst the results for NaCl calculated from e.m.f. data and those determined from direct vapour pressure data, an arbitrarily selected vapour pressure curve is adopted. This curve is found to yield the activity coefficients of KCl remarkably well. The method yields results whose accuracy is comparable with that of the best e.m.f. measurements.

AUTHORS.

4107. Vapour Pressure of Zinc Bromide-Diethyl Ether Solutions. H. H. Rowley and F. V. Olson. *Am. Chem. Soc., J.* 61. *pp.* 1949–1952, *Aug.*, 1939.—A study of the vapour pressures of the system zinc bromide-diethyl ether over the temperature range -10 to $+35°$ has been made. The existence of the two etherates, the dietherate of zinc bromide, $ZnBr_2 \cdot 2(C_2H_5)_2O$, and the monoetherate, $ZnBr_2 \cdot (C_2H_5)_2O$, has been indicated by (*a*) breaks occurring between 0 and 5° and in the neighbourhood of 20° in the curve obtained by plotting the logarithms of the vapour pressures of the system against the reciprocal of the absolute temperature; (*b*) analyses of the wet solids in contact with the saturated solutions at 0, 15 and 25°; (*c*) changes in the appearance of the solids in the ranges 0 to 5° and in the neighbourhood of 20°. Disagreements with Raynaud on the system zinc bromide-diethyl ether are mentioned, and possible sources of error in his work indicated. [See Abstract 2726 (1937).]

AUTHORS.

4108. Vapour Pressure Curve of Liquid Helium below the λ-Point. B. Bleaney and F. Simon. *Faraday Soc., Trans.* 35. *pp.* 1205–1214, *Sept.*, 1939.—A rational vapour pressure curve for He below the λ-point is calculated; from the λ-point down to 1·6° it is in good agreement with the values of Schmidt and Keesom, but then deviates towards lower pressures. Tables and diagrams of the vapour pressure and latent heat are given. It follows from these calculations that the chemical constant of He is within 0·01 of the theoretical value. AUTHORS.

See also Abstract 3879.

ACOUSTICS.

4109. New Definition of the Partial. F. H. van den Dungen. *Comptes Rendus*, 209. *pp.* 199–201, *July* 24, 1939.—This paper is a contribution to the theory of vibrations, and considers the meaning of first and second partial differentials with respect to deformations where the latter are used in place of velocities. With this new viewpoint, various propositions in the theory of vibrations, such as the formulæ of Rayleigh and Dunkerley, are found to be more easily derived, and a general expression is realised which is useful also for the cases of an open sonorous pipe or of a rod in torsion. H. H. Ho.

4110. Calculation of Chladni Patterns on Circular Plates. J. K. Stewart and R. C. Colwell. *Acoustical Soc. of America, J.* 11. *pp.* 147–151, *July*, 1939.—The approximate solution to the problem of circular

plates, in terms of Bessel functions, is given by the equation $W = AJ_n(k$ $\cos n(\theta - \alpha_n) - BJ_m(k'r) \cos m(\theta - \alpha_m) = 0$, in which the first term Kirchhoff's solution, representing circles and radii. The paper gives graphical method whereby the nodal patterns corresponding to variou value of B/A may be delineated. Several examples are worked out, and number of photographs show that two normal vibrations may occur at th same time on a circular plate, and thus produce symmetrical figures whic are neither diameters nor circles. J. P. A

4111. Vibrations of Free Square Plates. Part I. Norma Vibrating Modes. M. D. Waller. *Phys. Soc., Proc.* 51. *pp.* 831–84 *Sept.*, 1939.—After a brief historical note, the paper describes the result systematic observations which have been made on the normal vibration of free square plates. The nodal systems are divided into seven classe and their further recognition is effected by the application of given rule The natural vibration frequencies found by measurement are in fair agre ment with Ritz's calculations. The relative frequencies of the highe partials agree with Chladni's observation that they are proportional t $m^2 + n^2$. For values of m and n exceeding three, it is found that th frequencies, relatively to the gravest 1|1 tone taken as unity, are give roughly by $\frac{1}{4}(m^2 + n^2)$. AUTHOR

4112. Recent Investigations of Organ Pipes. A. T. Jones. *Acoustical Soc. of America, J.* 11. *pp.* 122–128, *July*, 1939.—A summary o recent studies of organ pipes with a discussion on these and some ne material. Reed pipes are, to a large extent, omitted, and the main point considered are acoustical quality including transient phenomena, and th means by which the sound is produced and maintained. In a closed pip the even components are present but rather faint (Boner). The qualit of pipe sounds is affected by the vibrations and material of the wall (Lottermoser). The development of the sound and the effect of transient (F. Trendelenburg), and the production and maintenance of the soun (Brown, Carrière, Klug) are described and illustrated. It is concluded tha in the cases of edge tones and flue pipe tones the sound is produced mainl by the varying air pressure brought about by the alternating flow of th blowing wind, first to one side of the edge or lip and then to the othe This alternating flow is aided, and its frequency partly determined, by system of vortices that usually accompany the blowing stream. G. E. A

4113. Influence of Angle of Incidence on Diffraction of Light b Supersonic Waves. E. A. Neumann. *Phys. Soc., Proc.* 51. *pp.* 794 802, *Sept.*, 1939.—Under appropriate conditions, a central minimum ap pears in the curve relating the total intensity of the light diffracted b supersonic waves to the angle α between the incident light beam and th sound wave-fronts ; it can be made to disappear gradually by decreasin the sound-frequency, the sound-excitation, or the length of the light-pat within disturbed medium. Diagrams are given showing these facts, th decomposition of a curve of the stated type into two halves belonging to th right and left orders respectively, the behaviour of individual orders, an the influence of the length of light-path within the disturbed medium on th total intensity of the diffracted light when the other variables, including α are kept constant, when a liquid is used as sound carrier. AUTHOR

***4114. Automatic Synthesis of Speech. H. Dudley.** *Nat. Acad Sci., Proc.* 25. *pp.* 377–383, *July*, 1939.—The automatic synthesis of speec carried out in two steps, *viz.*, electrical analysis of the speech followed by it re-construction by an electrical synthesising circuit, is described. B

nalogy the analyser may be regarded as an artificial ear and the synthesi-er as an artificial vocal system. Pitch and spectrum of speech are eparately determined by the analysing electrical circuit, while the syn-hesiser fashions its synthetic speech out of two basic sound streams, *viz.*, buzzer-like tone from a relaxation oscillator, and a hiss from random ibrations in the electrical current in a gas tube. The fundamental requency of the buzz is varied to simulate the pitch of voiced speech with ts inflection, while the spectral variation of amplitude with frequency s simulated by controlling the relative amounts of power transmitted in ixed frequency bands. The equipment can be adapted to obtain hybrid oices, *e.g.*, voices formed with the pitch of one speaker and the spectrum of another. [See also Abstract 2963 (1939).] J. S. G. T.

4115. Register Changes in Singing. Part II. Frequency Disturbances caused by Action of Resonance Cavities. W. Trendelenburg. *Preuss. Akad. Wiss. Berlin, Ber.* 21. *pp.* 188–226, 1938.—The question of the disturbing effect due to the coupling of the cavities of throat and mouth with the primary vibrating mechanism in the case of resonance between these two vibrating systems is investigated in two ways, the first by singing the vowel series *oo-oh-ah*, or in reverse order, at constant frequency, the second by gliding up and down the scale with mouth and throat unchanged. Using the first method with men's voices, no coupling effect is found. Observed disturbances of frequency are attributed to nerve effects in the laryngeal muscles during the change in the shape of the mouth. With women's voices also there was no evidence of disturbance due to coupling effect. Similarly there was an absence of coupling effect during the application of the second method, but with children's and women's voices there were frequency disturbances during the transition from the middle to the head register. It is concluded that, in singing, disturbances of frequency due to coupling effect play a very subordinate part. Breaks in the register are caused by difficulties in changing the shape and tension of the parts of the larynx involved. [For Part I see Abstract 3794 (1938).] G. E. A.

4116. Fluctuation of Threshold of Hearing. S. Lifshitz. *Acoustical Soc. of America, J.* 11. *pp.* 118–121, *July*, 1939.—Observers were given groups of five sounds of equal intensity. Each sound had a frequency 1000, a duration of 0·4 sec. with an interval of 0·6 sec. Starting with a loudness of 40 phon, the loudness was diminished for each succeeding group until (a) one of the impulses seemed shorter than the others, then (b) one of the impulses disappeared, and finally (c) all disappeared. The average above the individual threshold (a)–(c) was 6 phon, and the average fluctuation of the threshold (b)–(c) was 2 phon. The fluctuation occurs for energy levels of the order 10^{-15} W/cm^2. Its cause is physiological. Within the range near the threshold the apparent duration of the sound impulse is perceived more distinctly than its loudness. [See also Abstract 2314 (1936).] G. E. A.

4117. Pressure of Sound Radiation. C. Schaefer. *Ann. d. Physik*, 35. 6. *pp.* 473–491, *July*, 1939.—The question of the pressure due to a sound wave, investigated by Rayleigh, is taken up, and explored by a direct method which leads to results differing from those reached by Rayleigh. It is shown that for feeble but finite sound vibrations the sound pressure is equal to the energy density, and not as usually quoted from Rayleigh. It is also pointed out that, for very intense sound vibrations,

the theory of sound pressure must take into account the unsettled conditions which these produce. G. E. A.

See also Abstract 4008 and
2258B. Pitch of Musical Instruments and Orchestras. B. van der Pol and C. C. J. Addink.
2264B. Synthetic Sound. J. F. Schouten.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

See Abstracts
2104B. Zero Voltage Indicators for A.C. W. Graffunder
2120B. New Capitance and Loss Factor Bridge for L.F. with Manual and Automatic Balancing. H. Poleck.
2218B. Electric Filters. P. Nicolas.

CONDUCTION AND DISCHARGE IN GASES.

4118. Formation of Ions in the Cyclotron. R. R. Wilson. *Phys. Rev.* 56. *pp.* 459–463, *Sept.* 1, 1939.—Measurements of the initial ionisation in a cyclotron, produced by the use of a filament, as a function of the pressure, electron emission, and dee voltage are presented. The amount of ionisation is found to be too high to be simply explained by an electron passing between the region between dees only once. A theory is proposed wherein some of the electrons are caught by the changing electric field between the dees and oscillate back and forth many times during a cycle of the dee voltage. Experimental observations which conform to the theory are described. AUTHOR.

4119. Energy Measurements of Reigniting A.C. Arcs. S. G. Eskin. *J. of Applied Physics*, 10. *pp.* 631–638, *Sept.*, 1939.—An oscillographic study of arcs formed between silver contacts in the rupturing of 120-V a.c. circuits containing resistive loads shows that reignition of the arc occurs at low speeds of contact separation. Data have been obtained by means of a ballistic wattmeter showing the effect of current and line voltage on arc energy for silver contacts opening at speeds from 0·024 to 16·7 in. per sec. In the low speed range reignition is more prevalent at 225 V than at 115 V, and restriking of the arc occurs at higher speeds for higher currents. The formation of an arc in reigniting cycles is believed to be due to field emission of electrons, an average field of $0{\cdot}30 \times 10^6$ V/cm. being found for all cases of reignition observed. Reignition occurred at potentials as low as 72 V and the intermediate glow discharge normally observed in the interruption of inductive circuits did not appear. AUTHOR.

4120. Hydrogen Arc. C. G. Suits. *J. of Applied Physics*, 10. *pp.* 648–650, *Sept.*, 1939.—The gradient E, total voltage e, and current density I in the 1 atm. hydrogen arc between pure carbon electrodes in the 0–10 A range are measured by an oscillographic method. An abrupt change in e takes place at 2 and 0·6 A, and in E at 2 A, leading to the identification of three states of the hydrogen discharge in this current range and pressure. Rapid motion pictures of this arc at pressures above atmospheric show violent arc movements originating from convection forces. The ex-

ponent of the E–i relation is found to be 0·70 for the normal arc state at $p = 1$ atm. AUTHOR.

4121. Influence of Kathode on Sparking Potential of Heavy Hydrogen. F. L. Jones. *Phil. Mag.* 28. *pp.* 328–337, *Sept.*, 1939.—The sparking potential of D_2 between parallel electrodes was measured throughout a range of gas pressures from 1 to 26 mm. for six different kathodes. As with H_2, marked dependence on the kathode material was found, especially at the minimum sparking potential. For each electrode the minimum sparking potential of D_2 was about 3 % greater than that of H_2, but at a pressure of 26 mm. the sparking potential of D_2 was 3 % lower than that of H_2. The second Townsend coefficient, δ/α, was calculated for H_2 and D_2 on the assumption that α was the same for both gases, and it was found that δ/α was the same for H_2 and D_2 when Z/ρ was from 100 to 150, but that when Z/ρ exceeded 250, δ/α for H_2 was from 20 to 100 % greater than that for D_2. It was therefore concluded that, when $Z/\rho = 150$, photoelectric emission is the predominant kathode process; but that, when Z/ρ exceeded 250, the secondary emission was due to the action of the positive ions. Further, it would appear that the actual velocity of the ions is of importance in the mechanism of secondary emission for the kathode. [See Abstract 3746 (1939).] AUTHOR.

4122. Thermal Conduction in High Pressure Discharge Column. R. Rompe and P. Schulz. *Zeits. f. Physik*, 113. 1–2. *pp.* 10–17, 1939.—In the high pressure discharge electrical energy is dissipated by radiation and thermal conduction; the latter includes "classical" conduction by transfer of kinetic energy as well as conduction by diffusion of excited atoms, light quanta, ions and electrons. It is shown in the case of the high pressure Hg discharge that only thermal conduction by diffusion of ions is comparable with the "classical" conduction in magnitude. In discharges with constant column width (power — 500 W/cm., $p > 10$ atm.) thermal conduction by ions is taken into account theoretically by a term which has the same dependence on temperature and hence power dissipation as the emission of radiation. For discharges with radius dependent on current intensity (20 to 80 W/cm.) consideration of ionisation heat conduction together with a constant "classical" heat conduction leads to a complete interpretation of the discharge and its properties. J. E. K.

4123. Mutual Interaction of Plasma Electrons. W. R. Haseltine. *J. Math. Phys.* 18. *pp.* 174–201, *July*, 1939.—This paper considers some of the processes taking place in a simplified model of the plasma or positive column region of an electrical discharge through gas at low pressure. Particular attention is given to direct mutual interaction of the electrons, and the effect of this on the distribution of velocities. The first part deals with the question in a general way. To determine the velocity distribution function, two balance equations are set up. One expresses the conservation of energy, and the second the conservation of momentum parallel to the field. From these is derived one non-linear integral equation. The geometry of the mutual scattering process is examined, and the necessary integrations are performed in so far as these depend on this geometry. As an example the case of elastic sphere collisions is carried through to a point where integrations over the distribution function, f, become necessary. In the second part the cross-section function σ is derived for electron-electron scattering. As an interaction potential, the shielded Coulomb value $V = (\epsilon^2/r)e^{-r/a}$ was used. In the third part an attempt is made to find functions which are solutions of the problem. Under the assumptions

used, it is found that the function $f_0 = (A/2\pi w_0^3) \exp.(-gw^2/w_0^2-(1-g)w^4/w_0^4)$ is a fairly good approximate solution. It is found that experimental conditions can exist for which the theory predicts a value of the parameter g nearly unity. This corresponds to a nearly maxwellian distribution. AUTHOR.

4124. Rôle of Electronic Pressure in Theory of Plasma Oscillations. R. Seeliger and M. Steenbeck. *Zeits. f. Physik*, 113. 7–8. *pp.* 526–530, 1939.—According to Langmuir's theory the frequency of plasma oscillations is independent of the wave-length so that the velocity of propagation is zero. It is pointed out that this would be altered if the kinetic pressure of the electrons were taken into account. In normal conditions this produces only a small correction and at any rate the whole description of the phenomenon in terms of waves with a definite phase is not legitimate unless the correction due to the kinetic pressure is small. R. P.

4125. Chemical Activation by Gaseous Ionisation. S. C. Lind. *J. Chem. Phys.* 7. *pp.* 790–792; *Disc.*, 792–794, *Sept.*, 1939.—A comparison is made of the utility of the gas ion clustering hypothesis and of a free atom or free radical chain mechanism reactions taking place under ionising conditions. AUTHOR.

4126. Transformation of Impulsive Voltages. Observations of Electron Scattering by Means of a Cloud Chamber. E. Heuse. *Zeits. f. Physik*, 113. 7–8. *pp.* 514–525, 1939.—An attempt is made to step up the voltage of an impulse by means of an air transformer in order to generate fast electrons. It is found, however, that the effective transformer ratio cannot be increased beyond 1·6, so that the method has no practical value. The scattering of the electrons generated in these experiments is observed in a Wilson chamber. R. P.

See also Abstracts 3982, 3983, 4105, 4131, 4153.

CONDUCTION IN SOLIDS AND LIQUIDS.

4127. Electronic Conduction in Crystals. R. Hilsch. *Naturwiss.* 27. *pp.* 489–492, *July* 21, 1939.—An account is given of recent results on the high-temperature conductivity of non-metallic crystals [see Abstract 1356 (1938)]. A KBr crystal containing traces of KH and fitted with two Pt electrodes shows ionic conduction in the dark and on illumination a primary photo-current with saturation effects. With one electrode of Pt and the other of Ca electronic conduction occurs in the dark, and on illumination a secondary photoelectric current is observed. This is explained as due to a combination of K^+ ions with electrons supplied by the Ca electrode. These secondary electrons can then leave the K atoms and partake in the conduction. The phenomenon of rectification by a KBr crystal between Pt and Ca electrodes is also discussed. An arrangement analogous to a 3-electrode valve is made by adding a Pt grid electrode in the body of the crystal. L. A. W.

***4128. Electrometer Triode. J. A. N. Thaes.** *Indian Journ. Phys.* 13. *pp.* 199–204, *June*, 1939.—Different purposes, for which Philips electrometer triode, type 4060, can be used, have been described with special references to the measurement of voltage. It is pointed out that when the voltage source has a high resistance, this particular tube can be used, in a circuit identical in principle with an ordinary valve voltmeter, in order to measure the voltage. AUTHOR.

***4129. Valve Wattmeter. D. M. Myers and W. K. Clothier.** *Journ. Sci. Instruments*, 16. *pp.* 302–309, *Sept.*, 1939.—An instrument has been developed for the measurement of power, voltage and current, within a wide range of frequencies. It depends on the differential action of four triodes which operate on non-linear portions of their characteristics. The instrument is applicable to a.c. or d.c. measurements, or to a combination of the two. A simple means of adjustment and calibration is provided, for use when a triode, or other circuit component, is changed. Voltage and current range switches are included, together with a sensitivity control, which allows a reasonable reading to be obtained at low power-factor. All readings are made on a d.c. milliammeter. AUTHORS.

***4130. H.V. D.C. Stabilisation. W. Hackett.** *Journ. Sci. Instruments*, 16. *pp.* 297–302, *Sept.*, 1939.—An equipment has been developed to permit the use of the public supply mains for the measurement of leakage conductance of condensers to an accuracy of $\pm\ 1{\cdot}5 \times 10^{-12}$ mho over a voltage range of 0-5 kV. The devices incorporated reduce by the order of 600 : 1 the galvanometer fluctuations due to displacement currents which arise from anomalous fluctuations of the supply voltage. For example, an effective constancy of 5 in 10^{-5} can be achieved with a supply which fluctuates by 3%. Theoretical consideration of the contribution of the various circuit components indicates means of obtaining a still higher degree of suppression. AUTHOR.

4131. Formation of Metallic Bridges between Separated Contacts. G. L. Pearson. *Phys. Rev.* 56. *pp.* 471–474, *Sept.* 1, 1939.—Low resistance bridges were formed between gold, steel and carbon electrodes having separations of $2\text{–}70 \times 10^{-6}$ cm. by applying voltages less than the minimum sparking potential. For a given pair of electrodes the field required to form the bridges is a constant and is $5\text{–}16 \times 10^{6}$ V/cm. Measurements of the temperature coefficient of resistance of the bridges identify them as consisting of the material of the electrodes. A study of their resistance as a function of the displacement of one of the electrodes shows that they may be pulled out as well as crushed. At voltages less than those required to form the bridges, field currents exist. These increase rapidly as the field is raised and attain a value around 10^{-10} A before the bridges are formed. Calculation of the maximum electrostatic stress on the electrodes at the time of breakdown gives a value 0·05 to 0·0005 times the tensile strength of the electrode material at room-temperature. The field is locally higher than that calculated because of surface roughness and the tensile strength is probably lowered by the local heating known to accompany field currents. The data therefore indicate that electrostatic force pulls material from the electrodes to bridge the gap. AUTHOR.

4132. Semiconductor Theory of Blocking-Layer and Point Rectifier. W. Schottky. *Zeits. f. Physik*, 113. 5–6. *pp.* 367–414, 1939.—A new theory of the unipolar processes at the metal-semiconductor interface is developed in which the semiconductor is no longer considered as playing the part of a poorly emitting electrode of a diode arrangement with the electrodes separated by a potential hill. The semiconductor is regarded rather as analogous to the vacuum of an electron tube, being the carrier of an electron gas of non-uniform density between the two metal electrodes. For greater layer thicknesses this vacuum analogy breaks down, and is better replaced by the analogy of a space containing hot Na vapour between two thermally emitting electrodes. It is shown that a space-charge layer

is formed which offers a resistance to the passage of electrons in one direction, but which disappears when the polarity is reversed. L. A. W.

4133. Electrical Conductivity of Thin Films of Mercury. E. T. S. Appleyard and J. R. Bristow. *Roy. Soc., Proc.* 172. *A. pp.* 530–539, *Sept.* 4, 1939.—The electrical resistance of Hg films deposited in very high vacua on surfaces cooled to various temperatures between 20·4 and 90° K. has been investigated. The thickness of the films has been estimated by direct weighing to 3%. The results indicate that the delayed appearance of conductivity as deposition proceeds is due to agglomeration of the Hg into solid droplets, and that the cause of the sudden onset of conductivity is the touching of these droplets. The temperature coefficients of resistance of these films are all positive and reversible after annealing at the highest point in the temperature range. From a study of these coefficients it is concluded that films above 500 Å in thickness deposited at 64° K. or lower can be regarded as coherent slices of metal, differing only from the bulk metal in being strained and in possessing a high residual resistance which can be modified by annealing treatment. [See following Abstract.] AUTHORS.

4134. Supraconductivity of Thin Films. Part I. Mercury. E. T. S. Appleyard, J. R. Bristow, H. London and A. D. Misener. *Roy. Soc., Proc.* 172*A*. *pp.* 540–558, *Sept.* 4, 1939.—Hg films prepared in high vacua have been examined in the supraconducting state. The transition temperature from the normal to the supraconducting state in films previously annealed at 90° K. or more is very close to that of the bulk metal. On the other hand, films deposited at 4·2° K. and not afterwards annealed show a displacement of the transition temperature downwards by about 0·2° K. In neither case is there evidence of any variation of transition temperature with the thickness of the films. The critical longitudinal magnetic fields required to restore normal conductivity in the films at various temperatures have been determined. If H_f is the critical magnetic field for a film at a definite temperature and H_m that for the bulk metal at the same temperature, it is found that at all temperatures H_f/H_m is larger than unity, and increases rapidly as the film diminishes in thickness. For a film of a definite thickness H_f/H_m increases steeply as the transition temperature is approached. It is inferred from this result that the depth of field penetration likewise increases steeply as the transition temperature is approached. [See preceding Abstract.] AUTHORS.

4135. Electrical Resistance of Ferromagnetic Amalgams. L. F. Bates and W. P. Fletcher. *Phys. Soc., Proc.* 51. *pp.* 778–783, *Sept.*, 1939.—The electrical resistances of a series of Co amalgams with concentrations 0·149 to 0·548 gm. of cobalt per 100 gm. of Hg were measured over the temperature range 20° to 340° C. The type of (resistance, temperature) curve obtained varied with the concentration of the amalgam, but a characteristic of every amalgam on initial heating was the sharp change in resistivity, from a value less than that of pure Hg to a value considerably greater, at a temperature in the neighbourhood of 340° C. The transition temperature was found to be lowered on subsequent heating. Similar changes were observed with Fe amalgams of concentrations between 0·243 and 0·497 % [See Abstract 2194 (1939).] AUTHORS.

4136. Dependence of Conductance on Field Strength. Part I. Tetrabutylammonium Picrate in Diphenyl Ether at 50°. D. J. Mead with R. M. Fuoss. *Am. Chem. Soc., J.* 61. *pp.* 2047–2053, *Aug.*, 1939.—The conductance of tetrabutylammonium picrate in diphenyl ether at

50° has been measured at 1000 ~ and low voltage and at 60 ~ under field strengths up to 15 kV/cm. over the approximate concentration range 10^{-3} to 10^{-6} N. Onsager's theory of the Wien effect is in good agreement with our data. Deviations of activity coefficients from unity calculated by the limiting law of Debye and Hückel agree in order of magnitude with the experimental values obtained from the conductance curves. AUTHORS.

See also Abstracts 4138, 4172 and

2103B. Compensation for Temperature Error in D.C. Instruments. C. Reher.
2113B. Surface Conductance of Insulating Materials Subjected to Alternating Voltage. L. Hartshorn and W. H. Ward.
2152B. Precision Resistances for High Frequencies. G. Keinath.

DIELECTRICS AND CAPACITANCE.

4137. Dielectric Behaviour of i-Butyl and i-Amyl Bromides. W. O. Baker and C. P. Smyth. *Am. Chem. Soc., J.* 61. *pp.* 2063–2071, *Aug.*, 1939.—The dielectric constants and conductances of isobutyl and isoamyl bromides have been measured with a capacity bridge at frequencies of 0·5, 5 and 50 kc./sec. at temperatures from −190 to 30° above their melting points. The substances have also been examined with a polarising microscope over these wide temperature ranges. It is found that, when the substances in the liquid state are cooled, they form glasses, which crystallise at low temperatures, their properties depending upon the degree of crystallisation brought about by thermal treatment. Examination of these and other, previously studied molecules leads to generalisations as to glass formation. It is concluded that molecules which pack efficiently in the liquid, but which do not form isotropic lattices, should tend to vitrify. The temperature of narrowest distribution of relaxation times may indicate the point at which the vitreous aggregates begin to dissociate. AUTHORS.

4138. Dielectric Breakdown in Ionic Crystals. H. Fröhlich. *Phys. Rev.* 56. *pp.* 348–352, *Aug.* 15, 1939.—A critical consideration of the theories of dielectric breakdown in ionic crystals proposed by Seeger and Teller [see Abstract 4656 (1938)] and by the author is given. It is shown that the main difference in the formulæ for the breakdown field is due to the fact that Seeger and Teller make the unjustified assumption that an electron transfers energy to the lattice vibration without changing its direction of motion. A mistake in the interaction between an electron and an ion, used by Seeger and Teller, is corrected. The author's condition for breakdown is discussed in greater detail than has been done hitherto. [see Abstracts 3397 and 3411 (1939)]. Remarks by **R. J. Seeger** and **E. Teller** (*ibid. pp.* 352–354). AUTHOR.

See also Abstract 3845 and

2080B. Transient Temperature Distributions in a Dielectric in an Alternating Field. C. Copple, D. R. Hartree, A. Porter and H. Tyson.
2081B. Properties of Dielectrics in Electric Fields Comprising Unidirectional and Alternating Components. L. Hartshorn and E. Rushton.
2083B. Power Losses in Mica. L. Hartshorn and E. Rushton.
2090B. Dielectric Properties of Glass. L. Hartshorn, E. Rushton and W. H. Ward.

ELECTROCHEMISTRY.

4139. Dielectric Loss Due to Polar Molecules in Solid Paraffin Wax. D. R. Pelmore. *Roy. Soc., Proc.* 172*A*. *pp.* 502–517, *Sept.* 4, 1939.—This paper describes an extension of the work of Jackson and Sillars [see Abstract 403 (1939)] who investigated the causes of dielectric loss in systems consisting of paraffin wax and an aliphatic ester. It con-

firms their conclusions that the loss in these systems is due to the rotation of the polar molecules and can be interpreted in terms of the Debye theory. The effect of different paraffin waxes has been studied and a suggestion is made that the dielectric relaxation time of these systems depends mainly upon the lengths of the carbon chains of the molecules of the shorter component, a conclusion borne out very strongly by the comparison of the behaviour of ethyl stearate and spermaceti in hexadecane as compared with their behaviour in a natural wax whose mean chain length was approximately 26. Finally experiments were made with esters containing two ester groups in each molecule and in agreement with expectations it was found that the dielectric loss was positive or negligible according to the relative sense of the two polar groups : when these were arranged so that the dipole components transverse to the chain had opposite sense, no dielectric loss was observed. On the other hand, when the dipole components had the same sense the dielectric loss had a maximum value (at any given temperature) for a particular frequency and the relaxation time corresponded closely with that anticipated from the chain length. This appears to confirm the conclusion that the loss is due to the rigid rotation of the carbon chains about their long axes, and also to indicate that chain compounds containing polar groups should be most effective as components of low-loss dielectrics prepared for practical use, when the molecules contain an even number of polar groups so arranged that one-half of the dipole components transverse to the chain have opposite sense to the remaining half. AUTHOR.

4140. Potentials of Simple Metal Ions at Dropping Hg Electrode. J. J. Lingane. *Am. Chem. Soc., J.* 61. *pp.* 2099–2103, *Aug.*, 1939.—The equation of the current-voltage curves in the electrodeposition of metal ions at the dropping Hg electrode has been discussed. When the reduced metal is soluble in Hg the dropping electrode is subject only to concentration polarisation. Experimental data have been presented which demonstrated that the half-wave potentials of metal ions are shifted somewhat to more negative values with increasing ionic strength of the solution. The characteristics of the half-wave potential are discussed, and an equation is derived relating the half-wave potentials to the ordinary standard potentials of the metals. The difference between the polarographic half-wave potential of simple metal ion and the ordinary standard potential of the metal is shown to be a function of three distinct factors : (1) the affinity of the metal for Hg ; (2) the solubility of the metal in Hg ; and (3) the kinetics of the diffusion processes in the solution and in the Hg drops. AUTHOR.

4141. Potentiometric Determination of Fluoride. G. W. Low, Jr. and E. H. Pryde. *Am. Chem. Soc., J.* 61. *pp.* 2243–2246, *Aug.*, 1939.—A technique is described for the determination of fluoride rapidly and accurately by means of a simple concentration cell. Interference of other ions can be eliminated entirely, since the procedure is applicable to the determination of fluoride in the distillate obtained in separating fluoride from all impurities. The range over which the method has been applied is 0·2 to 60 mg./l. in a 5-cc. sample which is taken for analysis. Results are given showing the method's applicabilty to water analysis and to the determination of fluoride in phosphate rock. AUTHORS.

4142. Diffusion of Discharged Ions and Electrode Phenomena. Part I. Formation of H_2O_2 and O_2. G. Heinrich and A. Klemenc. *Zeits. f. phys. Chem.* 184. *Abt. A.* 5. *pp.* 347–366, 1939.—The authors

point out that since diffusion occurs away from the electrodes, reactions will occur not only at their surfaces but also at some distance away in the electrolyte. At the anode, hydroxyl ions are discharged, but for production of oxygen a further production of free (OH) radicals is necessary; these can then produce H_2O_2 which liberates O_2 spontaneously at the metal electrodes. If the reaction actually takes place in this way, the identification of H_2O_2 in the immediate neighbourhood of the anode should be practicable, but so far this has not been accomplished with certainty. By consideration of conditions deduced from Fick's law the authors investigate, by use of differential equations, whether it is reasonably possible to discover the presence of H_2O_2 in the solution. From the plot for per cent O_2/ time they conclude that it is impossible, in view of the relatively small amounts of O_2 concerned. D. R. H.

See also Abstract 4022 and
2069B. Anodic Oxidation of Al. J. W. Cuthbertson.
2098B. Electrolytic Condensers. P. R. Coursey and S. N. Ray.
2116B. Determination of Total Dissolved Solids in Water by Electrical Conductivity. H. Gustafson and A. S. Behrman.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

4143. Rate of Ionisation in Aqueous Solution of the C-H Bond in Aliphatic Compounds. K. F. Bonhoeffer, K. H. Geib and O. Reitz. *J. Chem. Phys.* 7. *pp.* 664–670, *Aug.*, 1939.—The rate at which the C-H bond ionises to give protons is studied by exchange with D_2O. A base catalyst such as OD^- ion is used. A large number of data are correlated in terms of the rate constants k at 25°. In some cases the calculations required to bring the data to comparable conditions are only approximate. The data are restricted to aliphatic compounds and include measurements on nitrohydrocarbons, acetone, acetaldehyde, acetic acid, acetonitrile, methyl sulphonic acid, halogenated compounds and hydroxyl compounds. The velocity constants of ionisation range from 10^3 to 10^{-7}, and the order in which the various substituents affect the rate of the CH ionisation is given. The influence of substitution on the ionisation constants of carboxylic acids has long been studied from the standpoint of thermodynamics. The ionisation of CH is a simpler process than the ionisation of COOH and it should be possible to learn more of the mechanism through kinetics.

AUTHORS.

4144. Reaction of Magnetic Moments in Rotating Magnetic Field. H. Dänzer. *Ann. d. Physik*, 35. 6. *pp.* 492–496, *July*, 1939.—In a problem dealt with by Güttinger and Pauli, if the spin of an atomic system at zero time is parallel to the lines of force of a magnetic field which is rotating round a fixed point with given frequency, there is a calculable probability that after a certain time the spin will have been reversed. The problem derives renewed interest through the experiments to determine the magnetic moment of the neutron. Güttinger's derivation of his formula is very general and the author derives it by more elementary methods. G. E. A.

4145. Angular Distribution of Fast Neutrons Scattered by Atoms. S. Kikuchi, H. Aoki and T. Wakatuki. *Phys. Math. Soc., Japan, Proc.* 21. *pp.* 410–420, *July*, 1939. *In English.*—The differential scattering cross-section for neutrons of 3·1 eMV energy was determined for H, C, Al, Fe, Cu, Sn, Sb and Bi. It was found that the scattering is not isotropic in all of the cases including the proton. Except in the case of the

proton, small-angle scattering predominates over the large-angle scattering, and the degree of asymmetry increases with the atomic number. The problem becomes complicated in the case of the proton, as the efficiency of the detector is different for the primary and the scattered neutrons owing to their difference in energy. It is concluded that the scattering is not isotropic referred to the system in which the centre of gravity is at rest, and that the usual theory of neutron-proton interaction, in which only *s*-interaction is taken into consideration, is not correct. AUTHORS.

4146. Sector Method in Electron Interference Photography. P. Debye. *Phys. Zeits.* 40. *pp.* 507–508, *Aug.* 1, 1939.—Continuing previous work [see Abstract 3428 (1939)] on the photography of electron interference phenomena using the rotating sector method, this paper describes a study of the possibility of applying a similar sector method to the copying of a photograph from a plate obtained by the older and ordinary methods of experiment. Equations are obtained for the effect of the sector in the two cases and it is shown that the effect of the sector on the blackening of a photographic plate is not the same as its effect on a stream of diffracted electrons. The rotating sector method is thus not a suitable one to use in the making of photographic copies. G. G.

4147. Electron Emission of Cu, Ag and Al due to Impact of High Speed Ions. E. Grassmann. *Ann. d. Physik*, 35. 5. *pp.* 465-472, *July*, 1939.—The electron emission of Cu is almost the same as that of Ag whilst for Al it is 5-7 times greater. The emission of Al, however, does not increase as rapidly with the speed of the ions as in the case of Cu and Ag. For ionic speeds of 7-15 kV, the electron current is 40-86% of the ionic current for Cu and Ag and 300-400% for Al. [See also Abstract 2973 (1938).] H. J. H. S.

4148. Electron-Optical Theory of the Plane Ideal Condenser. R. Herzog. *Zeits. f. Physik*, 113.3–4. *pp.* 166–187, 1939.—Equations are derived and discussed for the paths of charged particles through an ideal plane condenser the field of which is homogeneous up to the edges of the plates and there sharply delimited. It is shown that the condenser field not only deflects but also has a cylindrical lens action on the beam; the positions of principal and focal points of the lens are determined. The theory is applied to kathode-ray tube deflecting systems and equations are derived for the distortion of the beam focus on deflection and for the dependence of deflection sensitivity on magnitude of deflection. Possible applications of plane condensers in mass-spectrographs are discussed. J. E. K.

4149. Chromatic Errors in Electron Microscope. M. v. Ardenne. *Zeits. f. Physik*, 113. 3–4. *pp.* 257–259, 1939.—The chromatic error is of importance when relatively thick objects are examined with the electron microscope. This error has been discussed in an earlier paper [see Abstract 2160 (1938)], but the values there given are all too high; they are now corrected. H. J. H. S.

***4150. Linear Accelerator. P. L. Hartman and L. P. Smith.** *Rev. Sci. Instruments*, 10. *pp.* 223–231, *Aug.*, 1939.—A treatment of the acceleration of particles by the linear resonance accelerator is given, including the calculation of the velocity distribution of particles emergent from the device and a method for improving the yield and the velocity distribution. Calculated curves showing these features are shown. The mass selection properties of the device are also considered. Focusing is considered briefly and a discussion of the characteristics of a quarter wave-

length line as applied to a resonance accelerator is included. The experimental features of a linear accelerator as built up are described. Probable particle energies to be expected from any future device of the kind are indicated. [See Abstract 1667 (1938).] AUTHORS.

See also Abstracts 3897, 3911, 3972, 4126 and

2100B. Representation of Plane Movement of Electrons in Magnetic and Electrical Fields by Complex Locus Vectors. H. Kleinwächter.

ELECTROSTATICS.

4151. Electrostatic Field Produced by Point Charge in Axis of Cylinder. E. Weber. *J. of Applied Physics*, 10. *pp.* 663–666, *Sept.*, 1939.—The general solution of the field distribution produced by a point charge at rest in the axis of a metallic cylinder is derived; and a simple approximation is given for the field strength on the surface of the cylinder. AUTHOR.

4152. Volta Effect and Periodic System. O. Scarpa. *Accad. Lincei, Atti*, 29. *pp.* 273–276, *April* 1, 1939.—It is shown that the Volta effect measured relatively to Pt varies periodically with increasing atomic number and that the periods correspond to those of the periodic system. The values for the contact potentials of the meters of the first group Cu, Ag, Au are at the lowest points of the diagram while the values for the alcali metals form the maxima. L. K.

***4153. Continuous H.V. Generators Using the Dust-Current Principle. M. Morand and A. Raskin.** *Comptes Rendus*, 209. *pp.* 297–299, *July* 31, 1939.—The neutralising effect of parasitic effluvia on the charge carried by the dust column during its exit from the ioniser is eliminated by surrounding the ionising tube by a concentric earthed tube. Bakelite tubes are found to be preferable to glass for potentials greater than 1 eMV but arrangements must be made to raise the temperature of the bakelite so as to increase its surface conductivity and thus prevent the accumulation of surface charge. F. C. C.

MAGNETISM AND ELECTROMAGNETISM.

4154. Experimental Refutation of Poisson's Deviation Law. T. Vahlen. *Preuss. Akad. Wiss. Berlin, Ber.* 28. *pp.* 304–309, 1938.—The author discusses the validity of Poisson's assertion that each of the rectangular components of the magnetic force at a point due to the magnetism induced by the earth's field in soft iron masses in the vicinity is a linear form of the rectangular components of the earth's field. It is pointed out that this result can be shown to hold only in the case of iron masses of certain shapes. The argument is supported by experiments showing the distribution of the magnetic field in the neighbourhood of a soft iron prism of triangular section in a homogeneous inducing field. W. S. S.

4155. Experimental Study of Antiferromagnetism. G. Foëx and M. Graff. *Comptes Rendus*, 209. *pp.* 160–162, *July* 17, 1939.—The constant ferromagnetism, possessed by Cr till beyond 1000° C. has been attributed to an anti-parallel orientation of the moments due to the interactions. In the pure metal as each atom is surrounded by 8 neighbours at very short distance (2·49 Å) the interactions are too strong for the disappearance of the anti-ferromagnetism by rise of temperature to be attainable. Some compounds were therefore studied in which the distance apart of the ions was sufficient to allow of the law of disappearance of anti-

refromagnetism as a function of the temperature to be observed. Experiments were made with Cr_2O_3. The variations of $1/\chi$ are shown in a figure. The coefficient of magnetisation at first changes little with temperature, increases more and more quickly when the antiparallelisms disappear, passes through a maximum and then decreases according to the law of Weiss. CrSb and $CrSb_2$ were also studied. J. J. S.

4156. Ferromagnetic Impurities. Part I. F. W. Constant and J. M. Formwalt. *Phys. Rev.* 56. *pp.* 373–377, *Aug.* 15, 1939.—A method has been developed whereby a permanent magnetic moment as small as 2×10^{-7} / cm.^{3} may be measured in any small solid specimen. Various materials were tested by this method for ferromagnetic impurities. To remove surface impurities it was necessary to dissolve away part of the specimen. Most metals then showed some volume impurity. In aluminium, however, the volume impurity was nonmagnetic but could be dissolved out and deposited on the surface in a ferromagnetic state. Measurements were also made on the magnetic hardness and hysteresis curves of the impurities; part of the impurity was found to be very " hard," with saturation incomplete at several thousand gauss and a coercive force $\sim$ 100–200, and part quite " soft," with a relatively large initial susceptibility. Other properties of these impurities are being studied. The method was also extended to single crystals of dia- or para-magnetic materials whose magnetic anisotropy could be easily detected and measured. AUTHORS.

4157. Theory of Ferromagnetism of Semiconductors. S. Miyahara. *Zeits. f. Physik*, 113. 3–4. *pp.* 247–256, 1939.—The dependence of the spontaneous magnetisation of the semiconductor on temperature is different from that of metals, and as there are noticeable differences, from the theoretical standpoint, between semiconductors and metals, the Weiss-Heisenberg theory is not applicable as it stands. The author's theory is based on Wilson's model of the semiconductor and Slater's theory of ferromagnetism [see Abstract 3882 (1936)]. It is pointed out that with previous theories the spontaneous magnetisation increases continuously as the temperature falls, whereas with the author's theory the spontaneous magnetisation may again diminish at a low temperature. This effect has been obtained by several experimenters. G. E. A.

4158. Suggested Mechanism of Magnetic Viscosity. A. Perrier. *Helv. Phys. Acta*, 12. 4. *pp.* 291–294, 1939. *In French.*—Some distinctive features in the process of magnetisation of bodies showing magnetic viscosity are discussed and it is suggested that some, if not all, of these may be accounted for on a mechanical basis. Certain experimental results seem to support this view. H. J. H. S.

4159. Magnetic Properties of Copper Amalgams. S. S. Bhatnagar, P. L. Kapur and G. Mittal. *Indian Acad. Sci., Proc.* 10*A*. *pp.* 45–54, *July*, 1939.—Magnetic properties of dilute as well as concentrated amalgams have been investigated. It has been shown that when dilute amalgams are prepared by prolonged electrolysis at room-temperature the diamagnetic susceptibility of the amalgams prepared is lower than that calculated on the mixture law and the results are in line with those of Venkataramiah ; but if the amalgams are prepared at low temperature, 0° C., within 4–5 hours or by grinding the components according to the method of Terry and Wright susceptibility value of the amalgams obeys the mixture law. This difference in the susceptibility has been explained by the authors, by suggesting the formation of paramagnetic oxides formed

during prolonged electrolysis at high temperatures. Amalgams of higher concentrations prepared by the grinding method, when fresh obey the mixture law but on keeping, even under vacuum, become less diamagnetic and the maximum difference in susceptibility values between a fresh and an aged amalgam is observed in one which contains 34% Cu. This is supposed to be due to the formation of compound. AUTHORS.

4160. Magnetic Susceptibility of MnF_2 at Low Temperature. H. Bizette and B. Tsaï. *Comptes Rendus*, 209. *pp.* 205–206, *July* 24, 1939.—MnF_2 undergoes a crystalline transition at −201°. Between this and room-temperature its susceptibility is given by $\chi_M = C_M/(T-\theta)$, where $C_M = 4{\cdot}08$ and $\theta = -113{\cdot}2°$ Abs. At temperatures below −200° the susceptibility diminishes with the temperature and increases very slightly with the field. The results closely resemble those for MnO [see Abstract 4694 (1938)]. W. R. A.

4161. Magnetic Properties of Myoglobin and Ferrimyoglobin. D. S. Taylor. *Am. Chem. Soc., J.* 61. *pp.* 2150–2154, *Aug.*, 1939.—The magnetic moments of the Fe atoms in ferromyoglobin and ferrimyoglobin have been determined to be 5·46 and 5·85 Bohr magnetons, respectively. The magnetic moments indicate that the Fe atoms are held by essentially ionic bonds in ferromyoglobin and ferrimyoglobin. The agreement of the magnetic moments with those calculated for the analogous hemoglobin compounds leads to the conclusion that magnetic interactions do not occur between the four hemes of hemoglobin. AUTHOR.

4162. Susceptibilities of Chlorides of Pd and Pt Triads of Elements. B. Cabrera and A. Duperier. *Phys. Soc., Proc.* 51. *pp.* 845–858, *Sept.*, 1939.—Measurements have been made on the variation of the magnetic susceptibility of the salts $RhCl_3$, $OsCl_2$, $IrCl_3$, $PtCl_2$ with temperature over a range of about 300° from room-temperature upwards. A torsion balance with electromagnetic compensation, of greater sensitivity than those previously described, and a special electromagnet were used. The results for the corresponding kation may be represented by an equation of the type $(\chi+K)(T+\Delta)=C$. [See Abstract 190 (1928).] AUTHORS.

***4163. Apparatus for Magnetic Testing at Magnetising Forces up to 5000 Oersteds. R. L. Sanford and E. G. Bennett.** *Bureau of Standards, J. of Research*, 23. *pp.* 415–425, *Sept*, 1939.—An apparatus is described for general magnetic testing in the range of values of magnetising force from 100 to 5,000 oersteds. Specimens of rectangular cross-section up to 3·8 cm. (1½ in.) wide and 1·9 cm. (¾ in.) thick can be tested. It is estimated that under favourable conditions values of induction or magnetising force accurate within 0·5 % can be obtained and that under ordinary conditions of routine testing the accuracy is within 1%. The apparatus is convenient and simple to operate and does not heat the specimen. [See also Abstract 3237 (1933).] AUTHORS.

4164. Magnetism and Chemistry. *Zeits. f. Elektrochem.* 45. *pp.* 583–629, *Aug.*, 1939.—Six papers on the relationship of the two subjects.

"Forms of Magnetism; Their Application, particularly in Inorganic Chemistry," by **W. Klemm** (*pp.* 583–593).—Reviews the atomic theory of magnetism, the path moment and spin moment of the electron, the diamagnetism present in all cases and its screening by the paramagnetic or ferromagnetic property of the atom, moments of ions of the rare earths and the crystal lattice, arrangements of atoms which are diamagnetic, normally paramagnetic, antiferromagnetic, ferromagnetic, or paramagnetic as in the electron gas. Discusses the possibilities of applying magnetic

measurements in solving chemical problems. Treats questions on the chemistry of transition elements.

" Magnetism and Organic Chemistry," by **E. Müller** (*pp.* 593–597).—All organic substances are either diamagnetic or paramagnetic, and the molar susceptibility can be expressed in terms of the atomic susceptibilities. At present the magnetic test is the surest criterion of a real radical state, and examples are given of its application to radical chemistry.

" Magnetism and Metal Research," by **E. Vogt** (*pp.* 579–608).—Deals with internal structure and bond relations in metallic phases, magnetism of metals and the number of valency electrons as in the rare earths, magnetism of the elementary transition metals, ferromagnetism, distribution of the electrons in the atom and in the metal, transition of electrons when one metal is dissolved in another.

" Kinetics of Separation Processes based on Magnetic Measurements," by **H. Auer** (*pp.* 608–615).—Describes the investigation of changes of state as in Au–Ni mixed crystals by means of the changes in their magnetic behaviour with change of temperature, determines the properties of a body such as Al + 5% Cu. from the time-change in its susceptibility when quenched from various annealing temperatures and also by a retrogressive process (*Rückbildungsverfahren*).

" Problems of Dia- and Paramagnetism," by **C. J. Gorter** (*pp.* 615–621).—Describes the magnetic properties of Bi and of the supraconductnig metals, discusses paramagnetic relaxation and dispersion.

" Problems of Ferromagnetism," by **W. Döring** (*pp.* 621–629).—At absolute zero all the elementary magnets are parallel to one another and the spontaneous magnetisation is identical with absolute saturation. With rise of temperature the parallel positions are loosened and finally the spontaneous magnetisation disappears at the Curie point. Deals with the internal field, the conditions under which an element may belong to the ferromagnetic group, the technical magnetisation curve, and the practical applications of ferromagnetic materials. G. E. A.

See also Abstracts 3991, 4037, 4144 and 2134B. Development of Magnetic Materials. C. E. Morgan.

MEDICAL RADIOLOGY AND ELECTROLOGY.

4165. Bio-Electrical Phenomena of the Nervous System and Their Application in Medicine. A. Baudouin and H. Fischgold. *J. de Radiologie et d'Électrologie*, **23**. *pp.* 296–303, *July*, 1939.—Describes further research in the application for medical clinical purposes of measurement and recording of the micropotentials which result from nervous conduction [see Abstract 5065 (1938)]. This phenomena has been applied to pathological changes due to tumours, etc., in the human brain, these changes giving rise to dead areas in respect to the development of potentials and so being of service in locating the situation of tumours, etc. The apparatus is only briefly described but the various methods of applying the electrodes to the skull are illustrated. The patient is surrounded by a Faraday cage to remove external interferences such as parasitic variations of the electrical mains but, in addition, account has to be taken of other electrical disturbances due to muscular movements, even movements of the eyeballs. Results with normal brains and patients suffering from pathological brain conditions are discussed. B. J. L.

4166. Bactericidal Effects of U.V. Radiation Produced by Low Pressure Mercury Vapour Lamps. L. R. Koller. *J. of Applied Physics*, 10. *pp.* 624–630, *Sept.*, 1939.—The killing effect of 2537 Å radiation has been studied, both for bacteria suspended in air and bacteria and moulds on surfaces. A 15-W sterilising lamp (giving 25 μW/cm. of 2537 Å radiation at 1 m. from the lamp) will kill 97-99% of B. Coli suspended in air at a distance of 24 in. in 10 secs. Accordingly in an air duct a 15-W lamp can sterilise approximately 200 cu. ft. of air per min. A 15-W sterilising lamp will kill B. Coli on the surface of agar at a distance of 10″ in 20 sec. The Bunsen-Roscoe reciprocity law applies to the killing of bacteria by u.v. radiation between the intensities of 2000 μW/cm^2. and 1·3 μW/cm^2. The lethal dose of 2537 Å radiation for B. Coli on agar is 6600 μW sec./cm^2. For practical purposes the effect of temperature may be neglected. A film of grease is very effective in shielding bacteria from radiation. The lethal dose of 2537 Å radiation for black mould spores is about 45 times that for B. Coli. The reciprocity law applies. The sensitivity of mould spores decreases with increasing wave-length and is negligible for 3650 Å. Low pressure lamps in u.v. transmitting glass produce concentrations of ozone of the order of 0·1 part per million. From these experiments it may be concluded that low pressure Hg vapour lamps when used under the proper conditions are very powerful bactericidal agents if the bacteria are directly exposed to the radiation, but that the effectiveness is greatly reduced by even such slight shielding as is offered by a film of grease. AUTHOR.

4167. Rapid and Convenient Method of Checking Kilovoltage in X-Ray Therapy. D. E. A. Jones. *Brit. J. of Radiology*, 12. *pp.* 554–558, *Sept.*, 1939.—Experience with a number of deep X-ray therapy units has shown that variations in X-ray output occur, which are often due to changes in the kilovoltage operating across the X-ray tube. By utilising the well-known property that, over a range of quality, suitably chosen filters of different atomic number behave differently as regards their X-ray absorption, a simple method for detecting such changes in potential has been developed, which can be used conveniently in an X-ray therapy department. The method consists simply in measuring the intensity of the X-ray beam when (*a*) heavily and (*b*) lightly filtered. The ratio of the two intensities is found to serve as a sensitive indication of the applied kilovoltage, and hence of the quality of the beam. The filters usually met with in an X-ray therapy department serve well for the purpose of the test. AUTHOR.

4168. Radioactive Sulphur for Biochemical Experiments. J. L. Tuck. *Chem. Soc., J. pp.* 1292–1294, *Aug.*, 1939.—In order to determine whether radioactive S in organic thio-compounds could be used in biological investigations, experiments were made to discover whether the S exchanged with radioactive S as H_2S, S″, and SH′ in aqueous solution. Although 5% of exchange could have been detected, none was observed. AUTHOR.

4169. Intensity of Radiation and Selective Action. J. van Roojen. *Brit. J. of Radiology*, 12. *pp.* 547–553, *Sept.*, 1939.—Selectivity of action of radiations on the cell constituents of tissues may be produced and enhanced, or decreased and reversed, by the application of lesser intensities of radiation than those commonly used. Selectivity is independent of the wave-length of the radiation. It is highly desirable that the possibilities of the use of low-intensity radiation in the treatment of malignant tumours be investigated. The only way in which such low-

intensity radiations can be applied over sufficiently long periods is treatment by means of γ rays. The principle of the cosine radiating surfaces enables this to be done in a practical and satisfactory manner. AUTHOR.

***4170. Radium-Needle Threading Apparatus. R. K. Scott.** *Brit. J. of Radiology*, 12. *pp.* 559–561, *Sept.*, 1939.

***4171. Radium Plaque Accessory. R. K. Scott.** *Brit. J. of Radiology*, 12. *pp.* 562–563, *Sept.*, 1939.

***4172. Electrical Supply from Mains for Electro-Medical Apparatus. A. Djourno.** *J. de Radiologie et d'Électrologie*, 23. *pp.* 364–368, *Aug.*, 1939.—The energy supply of electro-medical apparatus from a.c. mains is generally discussed. Rectification may be by various means, *i.e.*, thermionic valves, vapour rectifiers, mechanical rectifiers, or Cu_2O rectifiers, utilising either one or both half-cycles of the supply. Rectification by valves is now most common and two valves for full-wave rectification can be replaced by a single valve with two filaments. H.f. disturbances can be filtered off by combinations of condensers and self-inductances. Methods of stabilisation of voltage of the rectified current are discussed, as well as protective measures and the advantages and disadvantages of this method of obtaining h.v., d.c. supply. B. J. L.

See also Abstract 4077 and
2170B. Million Volt X-Ray Tube. J. H. van der Tuuk.

OSCILLATIONS AND WAVES.

4173. Diffraction and Radiation of Electromagnetic Waves. S. A. Schelkunoff. *Phys. Rev.* 56. *pp.* 308–316, *Aug.* 15, 1939.—Inasmuch as it is rarely possible to treat diffraction of electromagnetic waves exactly, the Kirchhoff formulation of Huygens' principle has been frequently used in approximate calculations. If the Kirchhoff formula is applied directly to the field intensities of the incident wave over the aperture, the diffracted field is found to be inconsistent with Maxwell's equations. If, on the other hand, this formula is applied to some auxiliary vector potential from which the diffracted field is subsequently deduced by differentiation, the result (although consistent with Maxwell's equations) depends on the particular choice of the auxiliary vector and in some instances, at least, is obviously unreasonable. The calculations of diffracted fields and radiation fields, based either on the Equivalence Principle or on the more general Induction Theorem, depend upon *a priori* verifiable approximations to the actual fields in the neighbourhoods of the sources of the diffracted and radiated waves. For this reason the author feels that these methods are preferable to those based on the Kirchhoff formula. Remarks (*ibid. p.* 316) by **J. A. Stratton** and **L. J. Chu.** [See Abstract 3467 (1939).] AUTHOR.

4174. Effect of Lorentz Polarisation Term in Ionospheric Calculations. J. A. Ratcliffe. *Phys. Soc., Proc.* 51. *pp.* 747–756, *Sept.*, 1939.—Some calculations are made concerning the propagation of waves through an ionospheric region having a parabolic distribution of electron-density with height. The Lorentz term is included, but the effects of electron collisions and of the earth's magnetic field are neglected. Expressions are deduced for the group path at vertical incidence as a function of wave frequency, and for the horizontal range covered at oblique incidence as a function of angle of incidence and wave frequency. The results are presented graphically and are compared with calculations in which the

Lorentz term is neglected. It is shown that experiments in which vertical-incidence and oblique-incidence propagation through region F are compared cannot be expected to be accurate enough to decide whether or not the Lorentz term should be included. AUTHOR.

4175. Experimental Verification of Diffraction Analysis of Relation between Height and Gain for Radio Waves of Medium Lengths. T. L. Eckersley and G. Millington. *Phys. Soc., Proc.* 51. *pp.* 805–809, *Sept.*, 1939.—Some (height, gain) curves obtained by von Handel and Pfister [see Abstract 2221B (1935)] from observations taken in an aeroplane on medium-wave broadcasting stations show that initially there is a diminution of signal-strength on going up from the ground. This feature is predicted by the complete diffraction theory of propagation from a vertical aerial over an imperfectly conducting curved earth, and can be represented by a simple analytical expression. It is also a consequence of the flat-earth theory, and the analytical expression of this initial drop is shown to be of exactly the same form for a flat earth as for a curved earth. As Norton has shown, in the flat-earth case the initial drop may be explained physically as an interference effect between a space wave and a surface wave, and the equivalence of the (height, gain) relation for small heights suggests that in the curved-earth case also the total signal strength is the resultant of a space wave and a surface wave, both reaching to points beyond the horizon by diffraction, and suffering the same attenuation relative to their flat-earth values. The theory shows that though the initial drop is negligible on very short and on very long waves, it should be observable in practice under the conditions in which the medium-wave tests were carried out. A (height, gain) curve for a value 10^{-13} e.m.u. of σ is calculated from the diffraction theory for comparison with the experimental curves of von Handel and Pfister, and very good agreement is obtained. The span of the initial drop and the slope of the eventually rising curve change rapidly as σ is altered, and it is suggested that aeroplane experiments on medium waves should form a useful method of determining the mean value of the conductivity σ of the earth over any given ground. AUTHORS.

4176. Dispersion of Radio Echoes from the Ionosphere. F. W. G. White. *Phys. Soc., Proc.* 51. *pp.* 859–864, *Sept.*, 1939.—The dispersion undergone by a short train of radio waves when it is reflected from the ionosphere is discussed. It is shown that, for all ordinary conditions of observation this dispersion does not give rise to any difficulties in the interpretation of experimental results, as regards either the time of travel or the amplitude of the wave train. AUTHOR.

4177. Diurnal Variation of Absorption of Radio Waves. F. W. G. White and T. W. Straker. *Phys. Soc., Proc.* 51. *pp.* 865–875, *Sept.*, 1939.—The total absorption of radio waves reflected from region F has been measured over Christchurch, New Zealand. The diurnal variation in this quantity has been investigated under conditions which exclude absorption at the top of the wave trajectory; the results refer to the absorption which is thought to occur in region E. The variation has been compared with that given by Appleton's theory of absorption in a simple Chapman region. The practical results are found to agree with the theory, as far as the diurnal variation is concerned, both in summer and in winter. The ratio of the summer absorption to the winter absorption is, however, smaller than it should be according to the theory. This discrepancy is discussed. It is shown also that when the waves are returned

from the intense E-region, instead of region F, the absorption is of the same order of magnitude, a fact which indicates that the absorbing zone is beneath region E in conformity with Appleton's theory. AUTHORS.

See also Abstract 3886 and

2232B. Receiving Impedance of Receiving Aerial. K. F. Niessen and G. de Vries.

2242B. Short-Wave Generator. E. W. B. Gill.

PHOTOELECTRICITY.

4178. Photoelectric Effect and Photoconduction of Phosphorescent Sulphides and of Fluorides. E. Voyatzakis. *Comptes Rendus*, 209. *pp.* 31–33, *July* 3, 1939.—A complex CaS shows a photoelectric effect when undried, a very small effect when dried and none at all when dried and kept *in vacuo*. ZnS shows no photoelectric effect but its considerable photoconductivity decreases very much when dried in air and still more when dried and kept *in vacuo*. The photoelectric effect of CaF_2 behaves in the same way as that of CaS. J. E.

4179. Optical Transmission and Photoconductivity of Se. G. Mönch. *Phys. Zeits.* 40. *pp.* 487–488, *July* 15, 1939.—The dependence of the position of the diffuse edge of the transmission band of the transparent red modification of Se was determined. From the similarity of the temperature-shift of the edge of this band to the temperature-shift of the photoconductive maximum of grey Se, and the similar position of the photoconductive maximum for both modifications at room-temperature, it was concluded that the photoconductive properties of grey Se are to be attributed to included traces of red Se. D. H. F.

See also Abstract 4127.

THERMIONICS.

4180. Thermoelectronic Study of Thoriated Molybdenum. P. Grauwin. *Ann. de Physique*, 12. *pp.* 88–160, *July–Aug.*, 1939.—This investigation is part of a study of the thermoelectronic emission of metals contaminated by Th, and deals with that from Mo coated with a monatomic layer of Th obtained by the internal diffusion of Th incorporated in filaments. The problem has already been treated by Dushman but his results have not been published separately. The data now obtained agree with those found by Dushman. The following parts of the subject are described: The activation and deactivation of Mo-Th, and the exhaustion of the Th content. The values of A and ϕ as functions of the coating layer. The behaviour of filaments in atmospheres of O_2 and of Hg. It follows from the results obtained that the utilisation of Mo contaminated with Th is much less serviceable than that of W. Historical and theoretical sections precede the experimental part of the paper. H. H. Ho.

See also Abstract 4150.